December, 1957

THE JOURNAL OF GLASS MANUFACTURING

# the glass industry

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AN OGDEN PUBLICATION DEVOTED TO GLASS TECHNOLOGY, ENGINEERING, MATERIALS AND GLASS FACTORY EQUIPMENT AND OPERATION

# the glass industry

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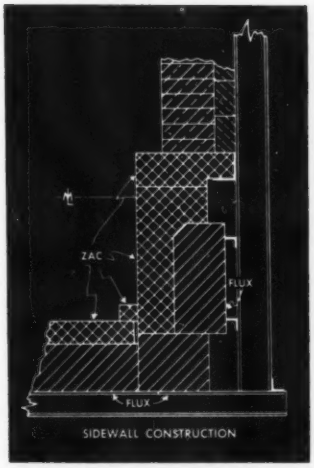

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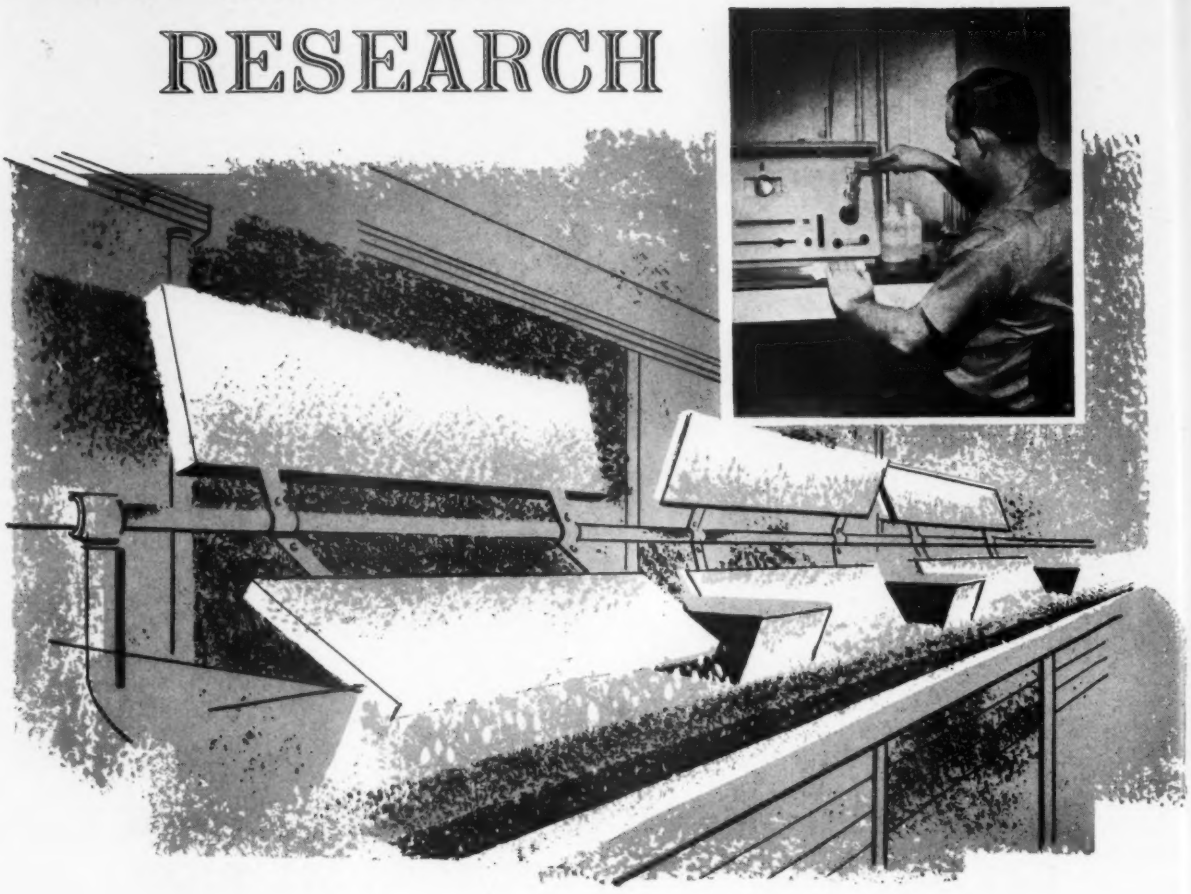

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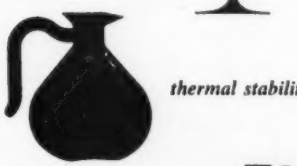
AFFILIATE: CANADIAN FLINT & SPAR DEPT., 77 METCALFE ST., OTTAWA, CANADA

# BORON:

*a vital constituent for glass*

*because $B_2O_3$ betters the batch*



Boron is much in the news today.
New, and sometimes startling, uses for boron are being found in rapid succession.
But the virtues and functions of boron trioxide are well known to the makers of glass.
They've been the major users of borax since ancient days. First, to make incomparable glazes; later, to impart to glass a desirable resistance to thermal and mechanical shock. Down through the ages into present-day usage, the four valuable properties of $B_2O_3$ have benefited the glass industry by—(1) improved fluxing of the batch,
(2) decreased coefficient of expansion,
(3) increased resistance to corrosion,
(4) influence on the refractive index.

From our lengthy list, the greatest diversity of borates and boron products in the world, we offer the following group as satisfactory sources for $B_2O_3$ for the manufacture of all types of glass:

- **ANHYDROUS BORAX,** $Na_2B_4O_7$
- **BORAX,** $Na_2B_4O_7.10H_2O$
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- **BORIC ACID,** $H_3BO_3$
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**United States Borax & Chemical Corporation**

*Pacific Coast Borax Company Division*

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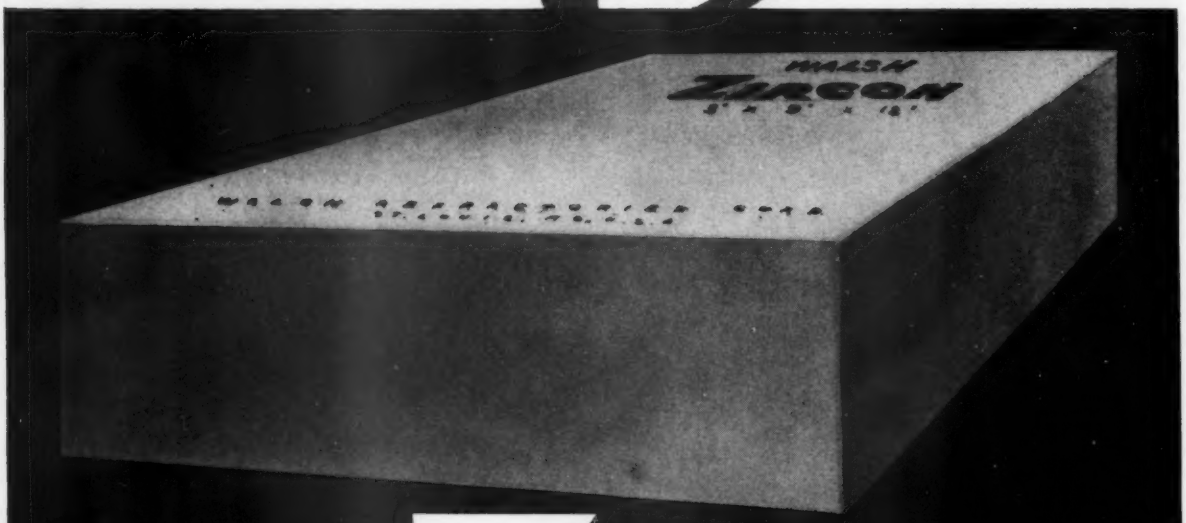
# Big

**REASON FOR BETTER GLASS AT LOWER COST**

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- **Weighs approximately 220 pounds per cubic foot; also available in higher densities.**
- **Available in various sizes and shapes to meet your requirements.**

**TECHNICAL DATA**

| | | |
|---|---|---|
| PCE—ASTM C 24-46 | | Cone 42 3659° F. |
| Porosity—ASTM C 20-46 | | 21-23% |
| Bulk Density—ASTM C 20-46 | | 220-225 lbs./Cu. Ft. |
| App. Sp Gr—ASTM C 20-46 | | 4.56 |
| Modulus of Rupture—ASTM C 133-49 | | 3,000 PSI |
| Cold Crushing—ASTM C 133-49 | | 20,000 PSI |
| Hot Load—ASTM C 16-49 | 2640° F. | 0.3% Deformation |
| | 2900° F. | 1.1% Deformation |
| Reheat Change—ASTM C 113-46 | 2910° F. | 0.11% Linear Shrinkage |
| | 3065° F. | 0.88% Linear Shrinkage |
| Panel Spall—ASTM C 122-47 | 3,000° F. Preheat | No Loss |

**Chemical Analysis available on request**

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***. . . THROUGH CHEMISTRY***

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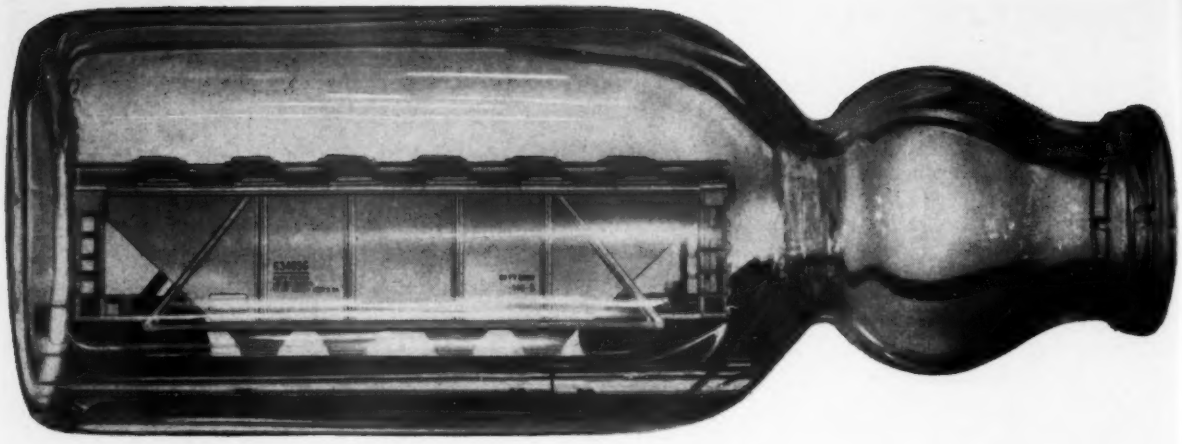

# the costliest raw material in the bottle...

... as in most glass products, is soda ash. Good reason why glass manufacturers pay particular heed to the purchase of this important raw material.

And the big question is: does it always arrive on time . . . in the grades and quantities needed to synchronize with your production?

Behind every delivery of Mathieson soda ash, there's over 60 years' experience in making, handling and supplying basic industrial chemicals. It's your best guarantee of assured, on-time supply.

Why not call up your Olin Mathieson representative today and discuss more profitable glass-making?

Mathieson soda ash for glass—dense and intermediate dense—is shipped in bulk carloads from Wyandotte, Mich., and Lake Charles, La.

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INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

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Polyamines • Soda Ash • Sodium Chlorite Products • Sodium Methylate • Sulfate of Alumina • Sulfur (Processed) • Sulfuric Acid

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Five years of commercial use has proved Drakenfeld Squeegee Oils 592 and 601 outstanding in the field of applied color labels. Prove them in your own plant — for performance, for economy, for results. Generous samples for test runs available on request. No obligation.

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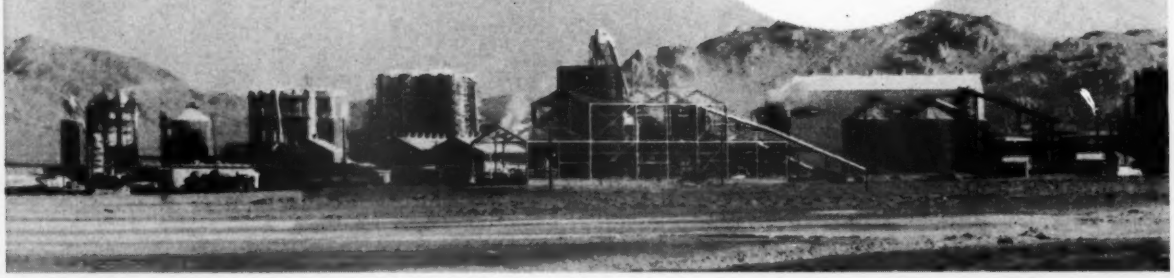
# West End anhydrous **SODIUM SULFATE** merits your confidence for its consistent purity

Here is the new high standard of sodium sulfate quality achieved by exclusive West End production techniques and controls. The product is pure white and exceedingly low in heavy metal content. It is guaranteed 99½% minimum $Na_2SO_4$ yet actually runs 99.75% to 99.8% $Na_2SO_4$ typically. We invite your attention to the adjacent typical analysis and welcome your communication.

TYPICAL ANALYSIS

| | |
|---|---|
| $Na_2SO_4$ | 99.5% or better |
| $Na_2O$ | .05% max. |
| $B_2O_3$ | .05% max. |
| NaCl | .07% max. |
| Insoluble | Trace |
| Loss on ignition | Less than 0.1% |
| Solution | Clear |
| Color | White |
| Fe | 1 ppm |
| As | 1½ ppm |
| Cu & Zn | Not detectable |



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DIVISION OF STAUFFER CHEMICAL COMPANY

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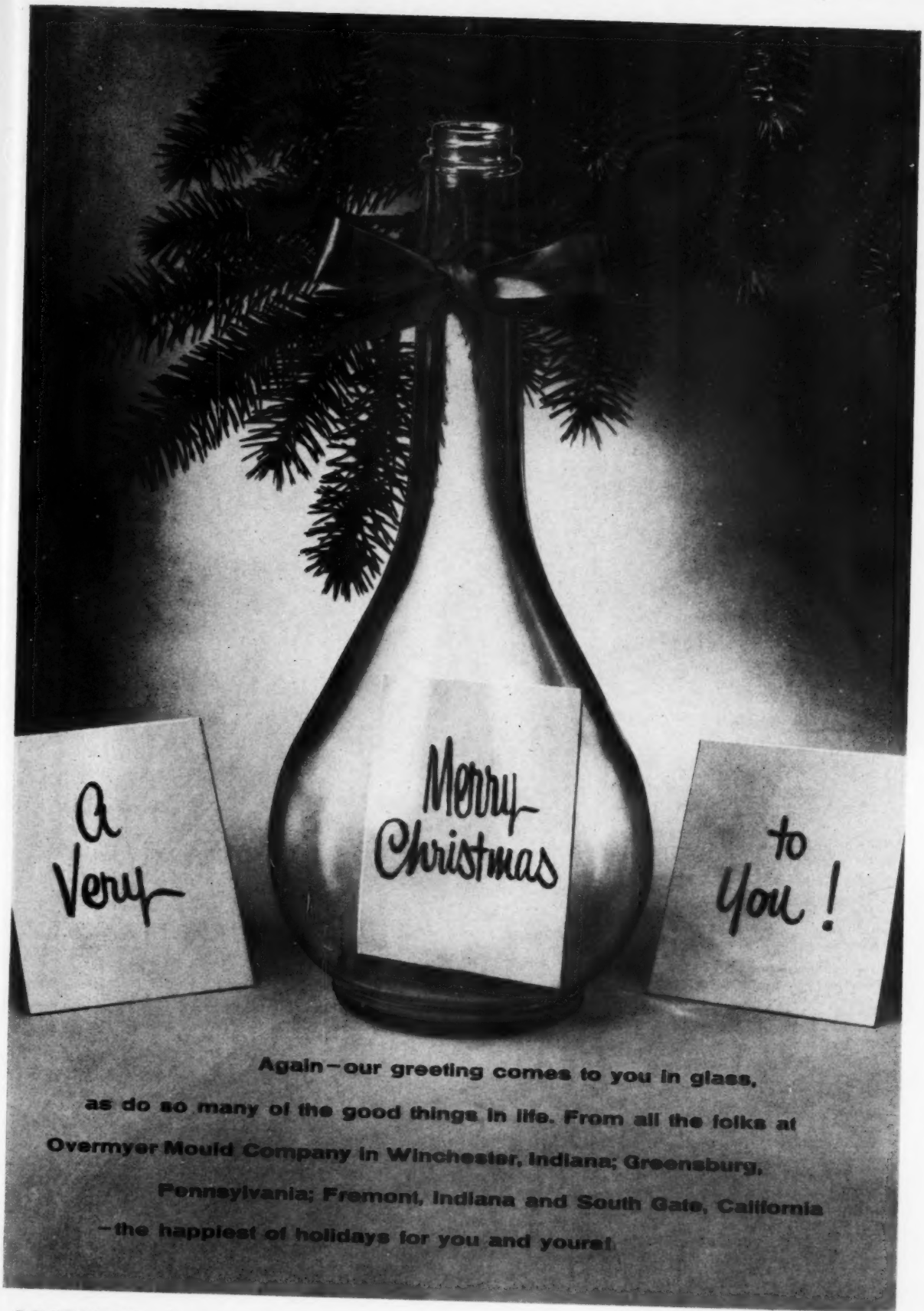
A Very
Merry Christmas
to You!
Again—our greeting comes to you in glass,
as do so many of the good things in life. From all the folks at
Overmyer Mould Company in Winchester, Indiana; Greensburg,
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—the happiest of holidays for you and yours!

# SELAS Gradiation® Heat Treats Plate Glass at Production Rates

**Versatile lehr, designed and built by Selas, processes glass for oven and broiler fronts, table and desk tops, TV protection shields and a variety of other products. Sixty 30- x 60-in. glass plates per hr. are heated to 1250°F by patterned Gradiation in a continuous, automatic operation. Smaller ware is handled at proportionately higher rates.**

The unique versatility and controllability of Gradiation heating contributes greatly to the strength and toughness of flat glass. Selas patterned heating gives reproducible uniformity . . . *through* the plate as well as on the surfaces . . . increases production . . . simplifies operation . . . saves time, money, space and fuel. Serving the glass industry also in bending, dropping, annealing, baking, fluorescent coatings, decorating, fusing and fire-polishing . . . Selas Gradiation methods are available in both batch and continuous processing.

Selas designs and builds heat processing equipment to meet your specific needs. *For information, address Dept. 1912, Selas Corporation of America, Dresher, Pa.*

*Gradiation is a registered trade name of Selas Corporation of America.*

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**DRESHER, PENNSYLVANIA**

*Heat and Fluid Processing Engineers*

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*but you pay no premium for the extra quality*

It's a fact! Westvaco Soda Ash is low in iron and insoluble residues. Derived from natural sodium sesquicarbonate, it contains less sodium chloride and sodium sulfate to begin with than other finished soda ash, too.

And, in addition to exceptional chemical purity, Westvaco Soda Ash has unique physical properties as well. It disperses and dissolves quickly, flows freely and has fewer fines and less tendency to dust.

As a result Westvaco Soda Ash is easier to handle, cuts production costs and has other practical advantages in many soda ash applications.

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HOW *Cambridge*

# WOVEN WIRE BELTS

## help produce more uniform ware faster

Woven Wire Conveyor Belts save time and money by providing continuous processing in every phase of glass manufacture—molding, inspection, annealing, decorating and cullet removal. In a time-saving belt-to-belt flow through the plant, woven wire belts combine controlled movement of the ware—bottles, flatware, pharmaceutical vials and specialties—with processing. Need for trays and racks is eliminated, manual handling is minimized, and product uniformity and production efficiency are effectively increased. EXAMPLE:

### Continuous Annealing

**MOVING BELT** carries hundreds of bottles through the lehr in a continuous stream after they are mechanically transferred from feeder belts. Woven wire feeder belts are preheated to reduce checking of ware as it is received hot from molding machines.

**OPEN MESH** of Cambridge belt allows free circulation of heat around the ware so that hot and cold spots are eliminated and each piece is uniformly heated.

**ALL-METAL BELT** withstands heat and flame curtain without damage, provides lasting strength because there are no seams, lacers or fasteners to break or wear. Wire belts are not cut by bits of broken glass in removal of cullet to crushers.

**SPECIAL RAISED EDGES** and surface attachments are available to hold even the smallest ware in position on the belt during flat or inclined movement.

**Cambridge Woven Wire Conveyor Belts are made in any size, mesh or weave, from any metal or alloy, and can be used under a wide range of conditions . . . high temperatures, moderate heat or cold . . . wet or dry. Call your Cambridge Field Engineer to discuss how you can cut costs with continuous processing on woven wire conveyor belts. Look for his 'phone number under "Belting, Mechanical" in the Yellow Pages or write for FREE 130-PAGE REFERENCE MANUAL.**

**The Cambridge Wire Cloth Co.**

Dept. K • Cambridge 12, Md.

WIRE CLOTH | WOVEN WIRE CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

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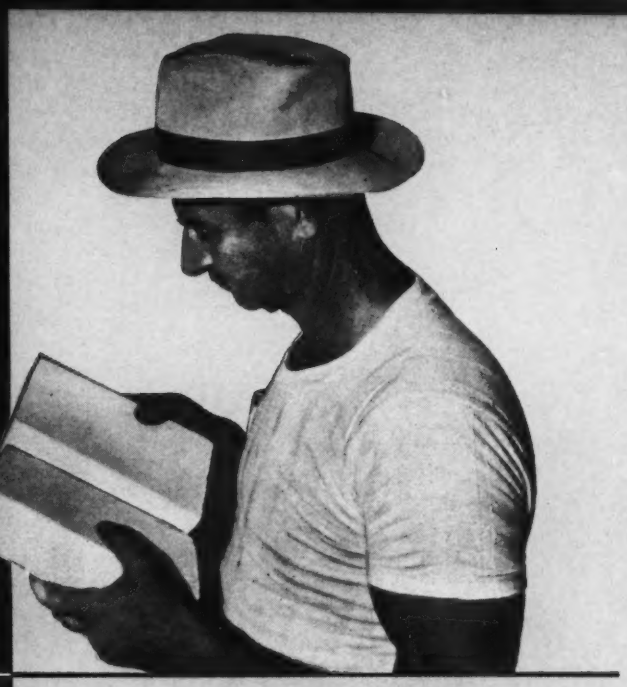
# *Are you getting the most for your Insulating Refractories dollar?*



Are you using, or are you planning to use refractory insulation in the construction of your glass melting furnace? If so, avail yourself of *all* the benefits of insulation —get the most for your insulating refractories dollar.

The maximum in insulating value plus the refractoriness needed for the temperature conditions involved are important considerations in the selection of the proper refractory insulation. After weighing these considerations and evaluating different types of materials, many glass manufacturers have selected *lightweight* B&W Insulating Firebrick to provide these benefits.

Here's why. B&W Insulating Firebrick are *lighter in weight* than any other insulating firebrick, which means they have low conductivity, insulate better (see Figure 1). This reduces radiation, which is lost heat, and results in substantial fuel savings. It also means improved working conditions around the tank, an additional benefit for you and your employees.

Lightweight B&W IFB save in other ways, too. They can be bonded with firebrick walls to reduce air leakage and infiltration, thus further reducing fuel consumption.

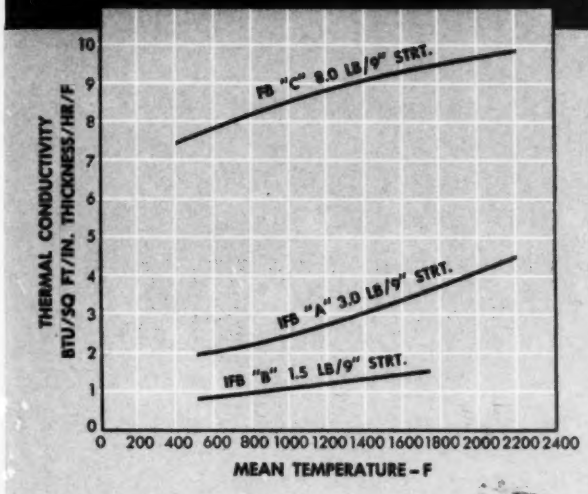



**FIG. 1**

**Thermal Conductivities of Various Weight Refractories**

There is a close relationship between the weight of the firebrick and its thermal conductivity. In general, the lower the weight, the lower the conductivity—therefore, the better it is as an insulator.

The chart shows this relationship between two insulating firebrick of 1.5 pounds per 9 inch straight and 3 pounds per 9 inch straight and a fireclay brick weighing from 7½ to 8 pounds per 9 inch straight.

### B&W Kaolite for Forehearth Channels

For quick, easy installation, B&W Kaolite is recommended for insulating sidewall and bottom forehearth channels. This lightweight insulating castable not only goes in fast, but also provides excellent insulating properties.

For your next tank rebuild, call in your B&W representative. He will be glad to give you the facts on Insulating Firebrick and Kaolite Insulating Concretes.

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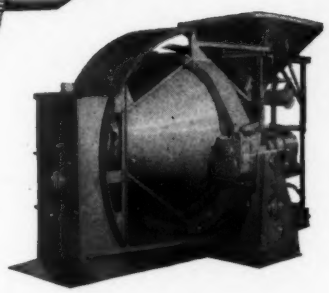
# intimate mix: braiding action

The place to start quality control is in the batch house.

A Smith Tilter actually braids particulate solids into an intimate mix. It is the only mixing drum that directs flow action into cross currents for complete random mix. Then it discharges without the slightest segregation.

*Sizes:* 30, 40, 60, 90, and 120 cubic feet, each completely dust-sealed.



**THE T. L. SMITH COMPANY**
**Milwaukee 1, Wisconsin**
**Lufkin, Texas**

**Affiliated with Essick Manufacturing Company, Los Angeles, California**

SMITH **batch mixer**

A-4020-1P

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R. W. Hopkins, President, Glass Technicians, Inc.

W. H. Manring, Vice President and Chief Engineer

## Columbia-Southern expands technical service

Columbia-Southern is happy to announce that greatly expanded technical assistance is now available to the glass industry. The well-known consulting firm of Glass Technicians, Incorporated, has been retained to supplement our own Technical Service Department.

Mr. Hopkins and Mr. Manring will act as field representatives for the combined service.

Personal and confidential consultations dealing with your problems will be arranged upon request to Columbia-Southern, as in the past. Why not call us today.

**Columbia-Southern, a dependable supplier of soda ash to the glass industry since 1899, manufactures its soda ash with extreme care to conform with the characteristics of other raw materials for superior glassmaking**

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the glass industry

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# The Glass Division at Bedford Springs

• UPWARDS OF 300 MEMBERS were registered for the fall meeting of the Glass Division of the American Ceramic Society, held October 17 and 18 at the Bedford Springs Hotel in Bedford Springs, Pa. A great many brought their wives. It was one of those rainy and misty weekends which dampened the spirits of some of the milder golfers who were reported to have been influenced in the direction of the ladies' bridge tournament on Thursday afternoon even to the extent of winning some of the prizes, but most of the golfers carried on as usual in spite of the weather. It had been agreed to shift the golf to Friday afternoon in case of rain on Thursday, but the golfers decided to play on Thursday anyway because they could then receive their prizes at the dinner Thursday evening and because the weatherman did not promise and did not deliver any respite anyway.

The Thursday morning technical session started quite promptly with a report by Harrison Davies on the 1957 Gordon Conference. He reported the conference as a success with attendance in the upper 60's, about half of whom were repeaters from previous years. The conference welcomed the presence of three foreign guests in the persons of Dr. Lindner from Sweden, Dr. Kirby from England and Dr. Tsuchihashi from Japan. Davies outlined the subject of the conference which was "Rate Processes in Glass" into the following five categories: Transport of Ions Through Glass, Relaxation of Stresses in Glass, Diffusion Processes, Nucleation Rates and Radiation Damage. He dwelt particularly on the experiments of McAffee from the Bell Telephone Lab who proved with $Si^{31}$ isotope that silicon ions would not diffuse in glasses or crystal at all and that diffusion of gases through glasses and crystals can serve as a sensitive measure of structure details. He reported the appointment of James E. Archer of the Pittsburgh Plate Glass Company as chairman for next year and Dick Charles of the General Electric Schenectady Lab as co-chairman. He named the following as possible subjects for next year's conference: New Methods in Glass Research, Chemistry of Glass Interfaces, High Temperature Phenomena in Glassy Materials, and Thermodynamic Studies of Crystals and Glassy Silicates.

In the second paper, Dale W. Rinehart of the Pittsburgh Plate Glass Company presented curves showing his measurements of dielectric loss in simple soda-alkaline earth-silica glasses. Starting with a silica soda ratio of 5:1, various mol percentages of calcium, strontium and barium oxides were added and the dielectric loss was plotted as tangent of the phase angle delta. Addition of the above oxides lowered tangent delta. Other slides showed that addition of magnesia causes a maximum at 15 mol per cent as does also zinc oxide. Addition of boric oxide or titania makes it go down and alumina or zirconia makes it go up. It is concluded from this large amount of measurement data that magnesia ions may be considered to be of an intermediate nature between network formers and network modifiers. These dielectric constant measurements were made at a frequency of one kilocycle at 78°F on 2-inch diameter 1/8-inch thick glass samples. The author believes that such dielectric constant measurements are indirect measurements of the size of the holes in the glass structure through which the alkali ions oscillate.

The next paper given by J. G. Sayre of Owens-Corning Fiberglas described an experiment involving the surface devitrification of a fused silica rod 5 mm. in diameter as it was suspended over a glass melt from which soda vapors were being given off. A ¼ mm. thick layer of devitrification material was scraped from the rod, was crushed in a steel mortar and then spread on a slide in preparation for electron diffraction measurements. The electron diffraction lines observed on the powder immediately after it was scraped off were identified as those of alpha cristobalite. After storing this powder in a 50 per cent humidity, the original alpha cristobalite structure remained but when the powder was stored in a 100 per cent humidity, crystallinity disappeared and the devitrified product apparently converted into a noncrystalline material, presumably a sodium silicate.

The third paper by R. D. Southwick described a very

interesting apparatus for the purpose of studying the "nature of friction between two glass specimens moving relative to each other at constant velocity under controlled ambient conditions." A hydraulic drive system which is capable of accurately controlling the slide velocity in the range from approximately $10^{-5}$ mm./second to 10 mm./second is used with a frictional force measuring system which consists of a linear variable differential transformer mounted in an aluminum proving ring. Preliminary experiments were carried out dragging a rod with a hemispherical fire polished end over a standard microscopic slide. Both static and dynamic friction experiments with rods weighted with between 50 and 100 grams allowed frictional force measurements accurate to 0.01 grams. Measurements showed essentially no effect of speed. A silicone wash drastically reduced the friction. Preliminary results in vacuum as well as under water were reported.

A thermodynamic approach to glass problems was explored by G. Sherwood Smith and Guy E. Rindone from the Penn. State Laboratories. Smith reported specific heat measurements as a measure of the energy content of various alkali borate glasses in the crystallized state and again in the glassy state using compositions of the stoichiometric formula of definite chemical compounds. Heats of fusion, heats of solution, entropies and free energies were calculated from the results. The specific heats and heats of transformation were measured using a modified Olsen calorimeter in which the sample and thermocouple are immersed together into the bath which is contained in a large Dewar flask.

Professor Charles H. Greene of Alfred University described a very ingenious experimental approach to the measurement of the rate of solution of oxygen gas into molten glass. A glass melt made in a cylindrical crucible assembled out of Vycor tubing and plates had a bubble artificially introduced. This was accomplished by starting with the glass charge in the form of two stacked glass cylinders one of which had a small cavity drilled into its top surface. As the glass cylinders fused together, a bubble of predicted size and of the composition of the furnace atmosphere was trapped in the melt. Using an oxygen atmosphere in the Globar furnace and rotating the crucible on a horizontal axis to prevent the bubble from rising, its size could be watched through a telescope peering into one end of the furnace and through the Vycor bottom of the crucible into the glass melt. Mercury light and an interference filter limiting vision to the ultra-violet helped visibility by cutting out the hgh red radiation of the temperature itself which was between 1000 and 1300°C. A mathematical equation relating the rate of bubble diameter shrinkage to the square root of time led to plotting according to these co-ordinates and Greene's experimental data approximately followed the theoretical straight line on this plot.

At the business meeting which was scheduled immediately before lunch on Thursday, it was announced that next year's Fall Meeting would again be held at Bedford Springs on October 17 and 18, 1958, and the 1959 Meeting is planned for Galen Hall at Wernersville, Pennsylvania. Dr. Günther, secretary of the German Glastechnische Gesellschaft who was on his first visit to the United States made the announcement that the Fifth World Congress on Glass would be held in Munich, Germany, June 29—July 4, 1959. Four days of conference and one day of excursions are being planned. It was also announced that the annual spring meetings of the American Ceramic Society had been planned four years ahead: at the Penn-Sheraton Hotel in Pittsburgh in 1958, at the Palmer House in Chicago in 1959, at the Biltmore in Philadelphia in 1960 and at the Royal York in Toronto in 1961.

At the Thursday evening dinner meeting, the delegates and their wives were entertained not only with an excellent steak dinner but also by the extensive awarding of golf prizes ranging all the way from golf balls and accessories to a beautiful large glass vase. The Meyer and Forrest Awards given annually by the Preston Laboratories were this year most deservedly awarded respectively to W. H. Otto of Owens Corning for his paper on the strength of glass fibers published in the *Journal of the American Ceramic Society*, 1955 (38), 122-24, in which he experimentally proved that the tensile strength of glass was the same per unit of cross-section in fiber as in bulk form, and to D. J. Todd of Corning for his paper in the *Journal of Applied Physics*, 1955 (26), 1238-43 on "Outgassing of Glass."

After presenting these awards, Dr. Leonard G. Ghering announced the Awardee for the 1958 Toledo Glass and Ceramic Award to be Dr. J. T. Littleton of Corning. This award will be presented at a dinner at the Toledo Club on January 20, 1958.

Professor W. E. S. Turner, founder and long time secretary of the Society of Glass Technology in England, brought us greetings from across the sea.

The principal speaker of the dinner meeting was the accredited inventor of modern fiber glass, Games Slayter of the Owens-Corning Fiberglas Corporation. His announced subject was "Compartments, Departments and Systems". Mr. Slayter criticized present day research and development laboratories as being too compartmentalized by which he means that each scientist is too prone to work only in his own little niche without having the opportunity of seeing the picture as a whole. He commended Bell Telephone Laboratories especially for their internal system of educating whole departments in what other departments are doing and explaining "where your department fits into the scheme of things". He described a shrinking world of today where no part of it will be more than three hours flying time away from any other part figured from the speeds of the jet airplanes which are now actually in process of manufacture for commercial service. He described the old world as a static structure built brick on brick, while in this modern dynamic world of energy, presumably obtained soon from atomic power, we in the glass industry must remember that one pound of glass is formed out of 2,000 btu whereas it takes 60,000 btu to form a pound of aluminum.

He said research, the business of making mistakes as cheaply as possible, is no longer the sure road to success. In contrast with this, the engineer must not make mis-

takes. As our horizon expands, so many excursions become possible that it is more important than ever to select the right direction for investigation. Therefore, successful research "requires constant integration into a system". The scientist himself must take the trouble to see where he fits. The scientist must discipline himself to advance to get there first with the best. Finally when a breakthrough is imminent, the whole company must work together to put through the improvement promptly. Sputnik beat us because we didn't get around to getting it up—not because we didn't know how.

These stark realities spoken by the man who has created his own success fell upon the ears of a closely attentive audience. The dinner and speeches were followed by dancing and the inevitable discussion groups which are the real work shops of the future advances for glass technology.

Russell G. Whittemore of the Pittsburgh Plate Glass Company started the Friday morning session with an invited paper giving us a "Historical Review of Glass Developments in Aircraft" within his company. Describing aircraft glass as a 15 million dollar business in 1957, he outlined the steps of development of first plastic, then laminated window glass, then laminated optically parallel plate and also bullet proof glass. Later even curved laminated side lites with some lites semi-tempered were called for. The necessity for bird resistance as well as bullet resistance followed as higher speeds were encountered. Flexible mountings, deicing and defogging devices were also described in detail.

Two more papers from the Preston Laboratories by Mould and Southwick, this time presented by Dr. Mould, describe the very thorough approach these laboratories are making to evaluate experimentally glass strength. With measured strengths ranging from a high of 170,000 psi for a pristine glass surface down to an average practical 6,000 psi for a scratched surface, this is obviously a most important variable. Their ambition to control the test precisely led them to use a standard grit blasted surface using silicon carbide abrasive of controlled size as the grit. All experiments are carried out in a controlled atmosphere box. Two knife edge loading was used to assure constant tension in the abraded area and the load was applied magnetically with electronic control of sudden start and stop in a square pulse wave. He proved that a succession of short pulse loads is equivalent to an equal static load.

Dr. Mould's second paper gave preliminary results in which he demonstrated crack healing with time but "if you wait a day, they won't change during the following week". Healing is faster in higher humidity. Under conditions of high vacuum, fatigue ceases. Curves were shown with each plotted point representing an average of 20 breaks and a standard deviation of 5-10 per cent was claimed. Experiments with emery cloth abrasion across and parallel to the direction of the applied tension caused differences in strength in the expected direction. A request from the floor afterward suggested publishing his individual data rather than just his averages so that statistical studies of the variation of strength between samples could be carried out.

Dr. Robert Gardon of the Mellon Institute presented a very interesting theoretical paper demonstrating his familiarity with heat transfer between air and glass such as occurs during the drawing, heating, tempering or annealing of glass sheet. The detailed equations which he stated were solved with the help of electronic computers were omitted from the presentation to be read in the printed paper. Numerous graphs showed temperature difference between center and surface plotted against time during different cooling and heating operations for opaque as well as clear glass.

The Bureau of Ordnance of the U.S. Navy sponsored the project on "Parallel Glass Fiber Laminates: Key to Super Strengths" which was next reported by A. H. Lasday of the Houze Glass Corporation. The audience was told that plastic-fiber laminates have grown in production by approximately 25 per cent each year since the war. Discussing the theory of plastic-glass fiber laminates, we were told that the manner of twisting and layering the fibers is most important. To achieve maximum strength, all the fibers must become taut together as tension is applied to a particular location, and it is of course most important to coat each individual fiber before it has a chance to become damaged by abrasion or atmospheric attack. The process described involved the simultaneous formation of 100 parallel fibers which are immediately encapsulated with resin milliseconds after their formation and are then wrapped on four foot diameter drums. The sheaf of 100 fibers is indexed back and forth until a mat .010 inch thick is formed. Successive mats are later laminated together alternating the fiber direction at different angles. The resulting material with a density one-quarter that of steel and a strength reported at 217,000 psi which is four times the strength of steel quoted at 55,000 psi, results in an overall strength increase per unit of weight of 16 times.

Dr. Burnham W. King of Battelle Institute in his paper described infrared transmitting glasses in the potash-antimony oxide-antimony sulfide system. We were told that these unusual low melting glasses were very stable against atmospheric attack and transmitted 40 per cent in the infrared region beween 2 to 7 microns. A refractive index well over 2 and density of nearly 4 were reported. A beautiful set of colored slides, mostly drawings, portrayed the glass sand mining operations as carried out by the Pennsylvania Glass Sand Corporation. Lawrence G. Burwinkel told, in an interesting manner, the story of sand mining along with the slides.

Paul Close, who is Chief Analytical Chemist at the Owens-Illinois Technical Center, outlined in procedure form a number of new analytical operations developed in his laboratory. He outlined the use of a platinum 250 ml flask with special funnel and bubbler tube for Ferrous Iron determined under a $CO_2$ atmosphere. An alternative cheaper polystyrene flask was also described. Arsenic and antimony analysis involves not only separating the two elements and analyzing for them separately but also separately analyzing for the two valence states of each one. This he does by separately determining 1) tri-valent arsenic plus tri-valent antimony, 2) penta-valent arsenic, then 3) determining the total antimony and the total arsenic from which he can by simple additions and

subtractions obtain the percentage of each valence of each of the two elements present. Analysis for total selenium has always been difficult of itself but a procedure whereby the following separate analyses of first total Selenium, then $Se^{+4}$, third $Se^{+4+6}$, fourth $Se^{0}$ and finally $Se^{-2}$ gives him sufficient information to calculate the correct percentage of each of the four possible oxidation states of selenium which is present in the glass.

Larry Penberthy gave a most challenging talk on "Major, Minor and Micro-Inhomogeneity in Glass". He stated that electric melting automatically adds homogeneity through its stirring action, and also eliminates those convection currents which are caused by furnace reversals. His latest electric furnaces have such small working ends that return flow is virtually impossible. He described platinum propellers working through molten tin seals and other stirring devices to achieve homogeneity but recommends the stirring action of electric melting as simpler and possibly equivalent. He mentioned that the skeletal structure of sand grains has been reported as still visible in conventionally rapid melted glass. He boasts that these "micro-stones" are eliminated in electric melting whereas eight hours of extra melting are required to melt them out when using conventional fuels.

The final of the contributed papers was given by Mr. Pitchford of the Pitchford Scientific Instruments Company. He described the X-ray spectographs manufactured by his company and their application to analysis of ceramic materials.

## PITTSBURGH PLATE TO BUILD DECATUR WINDOW GLASS PLANT

Pittsburgh Plate Glass Company has announced that the general construction contract has been awarded on a multi-million dollar window glass plant to be located near Decatur, Illinois.

The ultra-modern plant will be located on an 80-acre farm site about four miles southeast of Decatur. General contractor will be Virginia Engineering Company of Newport News, Virginia.

According to Robinson F. Barker, vice president in charge of the company's glass division, the new facility will utilize newly developed mechanical and electronic equipment in the manufacture of window or sheet glass. Approximately 350 employees will be required to operate the new plant.

Site preparation work has already begun and erection of the five story structure will begin in March. Estimated completion time on the project is 13 months.

Pittsburgh Plate's expanding fabricating plant at Lincoln, Illinois, will be supplied glass from the new Illinois plant. The Lincoln plant produces Twindow units, glass to glass sealed insulating windows which are finding a rapidly expanding market.

The unit will contain approximately 450,000 square feet of manufacturing and storage space. Planned production includes all commercial thicknesses of window and sheet glass.

Initially, the plant will have one glass tank and four Pennvernon drawing machines. The glass tank will be larger and the four glass ribbons produced by drawing machines will be considerably wider than those in older Pittsburgh Plate Glass window glass factories.

## TWO GLASS LEADERS AMONG "FIFTY FOREMOST"

The glass industry was represented by two Toledoans in America's "Fifty Foremost" business leaders honored at a dinner in the grand ball room of the Waldorf-Astoria in New York on Wednesday, Nov. 6. They are John D. Biggers, chairman of Libbey-Owens-Ford Glass Company, and Harold Boeschenstein, president of Owens-Corning Fiberglas Corporation.

Selection of the 50 men to be honored was made by members of leading national trade associations and by thousands of other responsible business men in a poll sponsored by Forbes' Magazine as a part of its 40th anniversary observance.

Many friends and associates of the Toledo glassmen were among 1,000 guests at the dinner.

**Glass leaders honored among America's "Fifty Foremost" business leaders: John D. Biggers, left, chairman of Libbey-Owens-Ford Glass Company, and Harold Boeschenstein, right, president of Owens-Corning Fiberglas Corp., both Toledo. Bruce C. Forbes, center, president of Forbes, Inc., presented the awards after reading citations.**

## CORNING ELECTS OFFICERS

Six officers were elected by the Corning Glass Works board of directors recently, it was announced by William C. Decker, company president.

George D. Macbeth was elected honorary vice president upon his retirement as vice president and controller. He will continue to serve on the board of directors and the executive committee.

Charles D. LaFollette was elected to the newly created office of financial vice president. Thomas Waaland was elected treasurer; John L. Ward, controller, and Robert W. Foster, assistant controller.

Norman J. Vang was elected vice president and director of industrial relations. Richard M. Clifford was appointed manufacturing manager of the Electrical Products Division.

• Bush Barnum has been named advertising and public information director of the Glass Container Manufacturers Institute according to a recent announcement by GCMI's board of trustees.

Mr. Barnum has been public information director of the Institute since he joined it in April of 1954.

# Sensitizing, Super-Sensitizing and Iridizing Compounds

**Part II**

**By SAMUEL WEIN**

**Quincy, Mass.**

This is the conclusion of a survey by Mr. Wein of the technical and patent literature he has reviewed.

• IRON OXIDE: Monakov and Totesh suspended iron oxide in water. Walker first rubs the glass surface with a little whiting, using a piece of flannel; this is rubbed off, and thereafter a little iron oxide is rubbed over the surface.

*Iron Sulphate*: Laval used this compound in the form of a rubbing pad, i.e., the powdered iron sulphate in a bag was made moist, rubbed over the surface and subsequently rinsed. The chemical formula for iron sulphate is $FeSO_4.7H_2O$, it is available as greenish crystals or in lump form, and it is effervescent, hence fresh solutions are always to be used. Monakov and Totesh use from 4 grams to higher quantities of iron sulphate per liter, and the standard quantity was 3.8 gram per liter.

*Magnesium Compounds*: Santomiere and, later, Bergstrom refer to the use of magnesium compounds but do not mention which one.

*Manganese Compounds*: Bergstrom refers to the use of manganese compounds, but does not state which one.

*Nickel Acetate*: Santomiere and Wheeler, McGinnis and Thordarson refer to this compound, but do not give details for its use.

*Nickel Chloride*: Is referred to by Wheeler, McGinnis and Thordarson, and Bergstrom, but they give no details for its use.

*Nickel sulphatepyridine*: This compound is referred to by Chakraborty and Banerjee.

*Osmium Compounds*: Are referred to by Bergstrom but he does not mention which one.

*Palladium Chloride*: This is a dark brown powder, its chemical formula is $PdCl_2$, and it is used mainly as a super-sensitizer for nickel and coppering techniques.

Sulzberger used "a few c.c. of an alkaline solution of palladium" for use with his nickeling process. No details are given as to the proper amount.

Paal and Frederici recommend between 0.005 to 0.05 gram per gallon.

Pragst suggests the use of sodium hydroxide with the palladium chloride solution.

Crehan uses 35 parts of palladium chloride to one million parts of water.

Baeyens first sensitizes the given surface, rinses, and immerses this in a silver nitrate solution, and this is again rinsed, thereafter followed by a dip in a hot palladium chloride solution, followed by a rinse.

In repeating the work of Baeyens in the Bureau of Standards laboratory, Dr. Brenner found that the use of silver nitrate solutions is not necessary. Dr. Brenner finds that if the tin chloride solution is 10 per cent concentration, the surface may then be repeated with a cold palladium chloride solution of 0.1 gram per liter.

Dr. Brenner suggested a hot palladium chloride solution whose concentration is 0.5 grams per liter, though lower concentrations such as 0.25 grams per liter was used. Brenner and Riddell recommended a momentary dip in a solution containing:

| | |
|---|---|
| Palladium chloride | 0.02 gram |
| Hydrochloric acid | 200 grams |
| Water | 1 liter |

Bergstrom first sensitizes the given surface with a tin chloride solution whose pH is 2.5; rinsing and subsequently treating with a solution of palladium chloride whose pH is likewise 2.5; and again washing with running water. Bergstrom forms films of cobalt by treating the super-sensitized surface with either acid or alkaline solutions of cobalt containing a suitable reducing agent, in this case, sodium hypophosphite or pyrogallol.

Pessel finds that 2 drops of a 0.1 per cent palladium chloride solution added to the reducing agent gives good results for coppering techniques.

Pearlstein recommends for room temperature super-sensitizing a solution of 0.1 gram palladium chloride per liter of water. The solution is at 125°F. for a two minute dip. Polystyrene was the material to be coated with nickel.

An interesting discussion by Dr. Narcus in the use of palladium chloride solutions as a super-sensitizer is worthy of careful consideration by those who are seriously studying the literature.

Raymond heats glass to 1200°F. then treats it with a 10 per cent palladium chloride solution. This technique is used for irridizing glass.

Dr. Brenner has made a comprehensive study in the use of palladium chloride solutions for use with nickeling techniques, and in his writings refer to the use of hydrochloric acid solutions of palladiums chloride, saying that if the acid is left out, it is necessary to stir (agitate) the bath thoroughly prior to its use in order to insure best effects (catalyzation) of the surface so treated. Furthermore, the palladium chloride solution is most effective in hot solutions for longest solution life. These hot solutions are most susceptible to decomposition or less bath life. Palladium chloride also causes a more spontaneous decomposition of the nickeling bath if any enters that processing bath. Even though the

surface to be coated is thoroughly rinsed in both cold and warm water after treatment in the "activator," there still seems to be spontaneous decomposition of the nickel bath—so called "black precipitate" formation which causes depletion of the nickel solution. A separate electroless nickel "strike solution" is usually necessary prior to the main bath when a palladium chloride treatment is employed. Conversion of the palladium chloride film to metallic palladium is a step in the right direction but when parts are processed in bulk there is much to be desired.

In spite of the fact that palladium chloride is a very expensive compound, the treatment of surfaces is relatively inexpensive, because of the very small amount of the solution is consumed in the process. At the current price of palladium (about $1.00 per gram), the solution will not cost more than about $0.02 per liter. Only very thin films of palladium are required; in fact the film used is almost of unimolecular thickness, (about $2 \times 10^{-8}$ cm. or $8 \times 10^{-9}$ in.) as judged by the palladium consumption. One liter of solution, containing 0.01 gram of palladium, is sufficient to treat 200 $dm^2$ (20 $ft.^2$) of surface.

Pearlstein has made a detailed study in the use of palladium chloride as a super-sensitizer for use with plastic surfaces, particularly that of polystyrene. The deposited metal in this case was nickel. Herewith follows a summary of his work.

*Experimental*: Polystyrene when roughened was immersed in a palladium chloride solution of 0.1 gram per liter of water, the pH was 1.7, without rinsing, and placed in an electroless nickel bath, there would soon be seen to form a film of metallic nickel thereon.

The next step in the process was to slightly roughen the polystyrene surface with steel wool. Subsequently a 30-second dip in a chromic-sulphuric acid cleaning solution was found effective for cleanser treatment.

The technique was to rinse the polystyrene panels for two minutes in the above palladium chloride solution of varying pH and temperature, rinsed and submerged in the electroless nickel solution. The results are shown in Table 1.

Table 1

Effect of pH and Temperature

| pH of $PdCl_2$ solution | Percent of Area Coated With Nickel | | | |
|---|---|---|---|---|
| | 80°F. | 110° | 125° | 165°F. |
| 3.0 | 0 | 0 | 2 | 10 |
| 3.4 | 0 | 15 | 25 | 100 |
| 3.8 | 0 | 99 | 100 | 100 |
| 4.4 | 40 | 99 | 100 | 100 |
| 4.8 | 90 | 100 | 100 | 100 |
| 5.8 | 0 | 2 | 5 | — |

As can be seen from Table 1, an increase in the temperature of the $PdCl_2$ solution increases the permissible pH range which can be satisfactorily employed.

In an effort to improve upon the process described above, consideration was given to the tin chloride solution. It was found that when polystyrene is given a $SnCl_2$ dip prior to the $PdCl_2$, the solution need not be heated, and a broader pH range may be employed. The following procedure was used:

1. Dip 1 minute in 96 grams tin chloride per liter of water plus 56 c.c. of hydrochloric acid at 80°F.
2. Rinse.
3. Dip 30 seconds in 01. gram $PdCl_2$ per liter of water of varying pH to 80°F.
4. Rinse.
5. Dip 1 minute in electroless nickel solution at 200°F.

The results are shown in Table 2.

Table 2

Effect of Tin Chloride Dip.

| pH of $PdCl_2$ Solution | Per cent of Area Coated With Nickel |
|---|---|
| 0.9 | 100 |
| 1.7 | 100 |
| 4.2 | 100 |
| 8.8 | 0 |

Table 3 shows the effect of pH when using a 0.01 gram per liter solution of $PdCl_2$. The permissible pH range of the $PdCl_2$ solution is decreased when the $PdCl_2$ concentration is decreased.

Table 3

Effect of Palladium Concentration

| pH of $PdCl_2$ Concent. | Per cent of Area Coated With Nickel |
|---|---|
| 1.0 | 0 |
| 3.0 | 70 |
| 4.1 | 100 |
| 6.4 | 0 |

The next step was to study the extent to which a stock solution of 0.50 grams $PdCl_2$ per gallon of water plus 5 c.c. hydrochloride acid could be diluted before the effectiveness of the solution was affected. The following procedure was used to obtain the data in Table 4.

1. Dip 1 minute in 70 grams tin chloride in 1 liter of water plus 33 c.c. hydrochloric acid at 80°F.
2. Rinse.
3. Dip 1 minute in various concentrations of $PdCl_2$ at 80°F.
4. Rinse.
5. Dip 1 minute in electroless nickel solution at 200°F.

Table 4

Effect of Palladium and Acid

| $PdCl_2$ Grams 1 liter | c.c. HCl | Per cent of Area Coated with Nickel |
|---|---|---|
| 0.5 | 5 | 100 |
| 0.1 | 1 | 100 |
| 0.02 | 0.02 | 100 |
| 0.004 | 0.04 | 10 |

When the solution containing 0.004 gram per liter of $PdCl_2$ plus 0.04 c.c. HCl was used at a temperature about 180°F. the polystyrene was completely coated with nickel.

In order to determine the minimum concentration of $SnCl_2$ which could be employed, solutions were made of a stock solution of 100 grams $SnCl_2$ per liter of water plus 50 c.c. of HCl. The following procedure was used to obtain the data in Table 5.

Table 5

Effect of Tin and Acid

| $SnCl_2$ Grams 1 Liter | HCl c.c. | Per Cent of Area Coated with Nickel |
|---|---|---|
| 100 | 50 | 100 |
| 20 | 10 | 100 |
| 4 | 0.4 | 100 |
| 0.8 | 0.8 | 100 |
| 0.16 | 0.016 | 100 |
| 0.32 | | 20 |

A small quantity of a wetting agent added to the $SnCl_2$ solutions seemed to be beneficial.

In order to test the ability of materials other than polystyrene to be activated by $PdCl_2$ solution, the processes described above were applied to the following materials: glass, Plexiglas, polyethylene, Mylar, cellulose acetate and the nitrate, Nylon, Saran, Teflon, Mycalex, a fragment from a porous aluminum oxide grinding wheel, and Textolite. The materials were roughened and cleaned before applying the activating treatments, and the following procedures were used:

Procedure A

1. Dip 2 minutes in 0.1 gram $PdCl_2$ per liter of water (pH 4.5) at 160° F.
2. Rinse
3. Dip 1 minute in electroless nickel solution at 200° F.

Procedure B

1. Dip 1 minute in 70 grams $SnCl_2$ in 1 liter of water, plus 40 c.c. HCl. at 80° F.
2. Rinse.
3. Dip 1 minute in 0.1 gram $PdCl_2$ plus 1 c.c. HCl at 80° F.
4. Rinse.
5. Dip 1 minute in electroless nickel solution at 200° F.

The results of these tests are shown in Table 6.

Table 6

Results

| Material Coated | Per Cent of Area Coated With Nickel | |
|---|---|---|
| | "A" | "B" |
| Glass | 1 | 100 |
| Polystyrene | 100 | 100 |
| Plexiglas | 60 | 100 |
| Polyethylene | 30 | 90 |
| Mylar | 100 | 100 |
| Cellulose acetate | 95 | 100 |
| Cellulose nitrate | 10 | 100 |
| Nylon | 100 | 100 |
| Saran | 99 | 100 |
| Teflon | 10 | 80 |
| Mycalex | 0 | 0 |
| Alumdum | 80 | 100 |
| Textolite | 100 | 100 |

Difficulty was encountered in completely coating some of the materials listed in Table 6 because of incomplete wetting by the solutions. Proper choice of wetting agents may rectify this situation.

*Phenyl Hydrazine:* Bassini and Bordini refer to the use of strong solutions of this compound, i.e., 5 to 50 per cent concentration.

*Rhenium:* Bergstrom refers to this compound but gives no details for its use.

*Rhodium:* Bergstrom refers to this compound but gives no details for its use.

*Rubidium:* Bergstrom refers to this compound but gives no details for its use.

*Silicon Dioxide:* This compound is referred to by Cox, in his patent, but he gives no details for its use.

*Silicon Tetrachloride:* This is a clear (colorless) to a pale yellow, heavy liquid. It fumes in moist air with a sharp and choking effect, and in water it decomposes to form a gelatinous silicic and hydrochloric acids. Its chemical formula is $SiCl_4$, and it is available from Stauffer Chemical Company.

Hyde forms irridescent films on glass by allowing the silicon tetrachloride to vaporize and deposit itself onto the glass surface, and subsequently heating to between 200 to 400 deg. C. The most effective way of obtaining the vapor is to pass a stream of dry air through the liquid silicon tetrachloride contained in a closed vessel, then conducting the vapor from the vessel by means of a delivery tube against the surface to be treated. Surfaces to be treated for irridizing according to Hyde are glass, ceramics, porcelain and fused silica.

Littleton refers to its use but gives no details.

The Anderson Laboratories, list it in their catalog as item #33 dimethyl dichlorosilane.

*Silver Nitrate:* Dilute solutions of silver nitrate after tin sensitization is referred to by Prof. Weyl as well as by Dr. Brenner for super-sensitizing use.

*Silver Oxide:* This compound is referred to by Cox in his patent, but he gives no details for its use.

*Strontium Compounds*: Are referred to by Santomiere but no details are given for its use.

*Tantalum Chloride:* Lytle refers to this compound but gives no details for its use.

*Thallium Chloride:* Littleton refers to this compound but gives no details for its use.

*Thorium Chloride:* Littleton refers to this compound but gives no details for its use.

*Thorium Oxide:* This compound is referred to by Cox in his patent, but he gives no details as to its use.

*Tin Chloride*: This compound is met with on the open market as a fine or coarse crystal, readily soluble in water at room temperature. Its chemical formula is $SnCl_45H_2O$. The author has been using "Stannochlor" anhydrous form as made by the Metal & Thermit Corp, and its chemical formula is $SnCl_2$. This latter compound has less water in its molecules and gives excellent results as a sensitizer.

Other tin salts such as the bromide, iodide, nitrate, fluoride, sulphate, potassium or sodium stannate, oxalate, etc. are recorded in the literature as sensitizers.

The cleaned surface is treated with a "dilute tin chloride solution and rinsed" according to Pratt as early as 1882.

Andres dissolved 90 grains of tin chloride per gallon of water for use as a sensitizer in his gilding process.

Holtzappel suggests concentrations of tin chloride from 0.25 to 0.5 per cent as sensitizer.

Smith and Fitzgerald use a 10 per cent tin chloride solution.

Mochel recommends

| | |
|---|---|
| Tin chloride | 100 grams |
| Water | 50 c.c. |
| Hydrochloric acid | 10 c.c. |

Bergstrom used between a 1 to 5 per cent tin chloride solution, made acid and so adjusted to a pH of 1 to 5, and the best results he records are at a pH of 2.5.

*Alcoholic Tin Solutions*: Kiefer dissolves tin chloride in alcohol and applies this to the plastic surface. Young and McAuley make a 10 per cent solution of tin chloride in isorpropyl alcohol, and reduce the hot tin oxide in the hydrogen flame. McMaster suggests the following proportions for use in irridizing glass whose temperature is between 550 to 650 Deg. C.

| | |
|---|---|
| Tin chloride | 1 part |
| Alcohol | 1 part |
| Water | 1 part |

In a modified solution McMaster uses no water but adds glacial acetic acid instead, thusly:

| | |
|---|---|
| Acetic acid, glacial | 1 part |
| Alcohol | 1 part |
| Tin chloride | 2 parts |

The temperature of the glass in this case was at 120 to 130 deg. C.

Lytle and Junge use ammonium fluoride in the alcohol-tin solution as for instance:

| | |
|---|---|
| Tin chloride | 1000 c.c. |
| Methanol | 5000 c.c. |
| Ammonium fluoride | 100 grams |

A modified formulation suggested consists of:

| | |
|---|---|
| Tin chloride | 1000 c.c. |
| Methanol | 2000 c.c. |
| Ammonium fluoride | 60 grams |
| Butyl carbitol acetate | 3000 c.c. |

Gaiser heats the glass to between 800 and 1200 deg. F. spraying it with a 10 per cent tin chloride solution in isopropyl alcohol. The rate of solution spray is 600 to 800 c.c. per minute.

*Tin Chloride With Organic Acids*: Lytle and Junge find that acetic acid with tin chloride will serve as a good film forming solution for irridizing use; the formula they use consists of:

| | |
|---|---|
| Tin chloride | 2 parts |
| Acetic acid (glacial) | 2 parts |

*Tin Chloride and A Reducing Agent*: A simple formulation suggested by Lytle is made up of:

| | |
|---|---|
| Tin chloride | 900 grams |
| Phenyl hydrazine hydrochloride | 21 grams |
| Methyl alcohol | 90 ml. |

A modification of this consists of:

| | |
|---|---|
| Tin chloride | 900 grams |
| Phenyl hydrazine hydrochloride | 21 grams |
| Wetting agent | 30 grams |
| Methanol | 63 ml. |

The wetting agent consists of:

| | |
|---|---|
| Sodium sulfosuccinate | 10 grams |
| Methanol | 45 mls. |
| Water | 43 mls. |

Ackerman, Cox and later Saunders use:

| | |
|---|---|
| Tin chloride | 20,430 grams |
| Phenyl hydrazine hydrochloride | 639 grams |
| Hydrofluoric acid (aqueous solution containing 48 per cent by weight of hydrofluoric acid). | 134 grams |
| Water | 7056 grams |
| Wetting agent | 918 grams |
| Methanol | 2250 grams |

It is claimed that such films will not peel once they have been formed at 1250 deg. F.

Lytle first, and then with Junge, records the mixture of formaldehyde and tin chloride as in the case of:

| | |
|---|---|
| Tin chloride | 90 per cent |
| Formaldehyde | 10 per cent |

*Tin Compounds With Binders*: Cowper-Coles made a mixture in the consistency of a paste with tin chloride and jewelers rouge as the binder. This was rubbed over the surface and subsequently washed off.

Franza used:

| | |
|---|---|
| Tin chloride | ½ ounce |
| Water | 1 gallon |
| White putty powder | 2 table spoonful |

Apply this mixture with a soft felt block to the glass surface, thereafter remove the film with a bristle brush and running water. This technique was used in connection with a coppering process.

Tillyer and Moulten suggested:

| | |
|---|---|
| Tin chloride | 40 grams |
| Tin oxide | 40 grams |
| Gum Arabic | 20 grams |
| Sugar | 1 gram |
| Water | 100 c.c. |

Instead of tin oxide, there may be used white rouge (very fine white silica). It also serves as a means to polish the glass surface.

*Tin Chloride With Other Metals*: There now follows a series of compounds using tin chloride with antimony, etc. salts. The uses of such films are intended for irridizing (decorative) as well as for electrical circuits, details of which we have already discussed.

In the following examples, according to Mochel, the solutions were sprayed for 15 seconds on borosilicate glass heated to about 700°C. The electrical resistance of the resulting irridized film was measured and their general properties are now given in the following order:

Example 1

The solution consists of 100 grams tin chloride, .0625 gram antimony trichloride, 50 c.c. water and 10 c.c. hydrochloric acid, this is equivalent to 99.91 per cent $SnO_2$ and .09 per cent $Sb_2O_3$. The fifth order film was

colorless by transmitted light and had an electrical resistance of 24 ohms per square and a positive temperature coefficient of resistance.

Example 2

The solution consists of 100 grams tin chloride, .5 gram antimony chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 99.26 per cent $SnO_2$ and .74 per cent $Sb_2O_3$. The fourth order film was colorless and had an electrical resistance of 12 ohms per square and a positive temperature coefficient of resistance.

Example 3

The solution consists of 100 grams tin chloride, 4 grams antimony chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 94.5 per cent $SnO_2$ and 5.5 per cent $Sb_2O_3$. The fourth order film was blue and had an electrical resistance of 21 ohms per square and a positive temperature coefficient of resistance.

Example 4

The solution consisted of 100 grams tin chloride, 8 grams antimony chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 89.4 per cent $SnO_2$ and 10.6 per cent $Sb_2O_3$. The third order film was dark blue and had an electrical resistance of 130 ohms per square.

Example 5

The solution consisted of 100 grams tin chloride, 1 gram antimony chloride, 8 grams manganese chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 91.3 per cent $SnO_2$, 1.3 per cent $Sb_2O_3$, and 7.4 $MnO_2$. Spraying time was 12 seconds. The fourth order film was colorless and had an electrical resistance of 32 ohms per square and a positive temperature coefficient of resistance.

Example 6

The solution consisted of 100 grams tin chloride, 4 grams antimony chloride, 16 grams manganese chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 81.8 per cent $SnO_2$, 4.9 per cent $Sb_2O_3$ and 13.3 per cent $MnO_2$. The third order film was colorless and had an electrical resistance of 36 ohms per square and a positive temperature coefficient of resistance.

Example 7

The solution consisted of 100 grams tin chloride, 1½ grams antimony chloride, 1 gram vanadium pentoxide, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 95.7 per cent $SnO_2$, 2.1 per cent $Sb_2O_3$ and 2.2 per cent $V_2O_3$. The fourth order film was colorless and had an electrical resistance of 42 ohms per square.

Example 8

The solution consisted of 100 grams tin chloride, ½ gram antimony chloride, ½ gram bismuth chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 98.4 per cent $SnO_2$, .7 per cent $Sb_2O_3$ and .9 per cent $Bi_2O_3$. The fourth order film had a faint brown tint and an electrical resistance of 50 ohms per square and a negative temperature coefficient of resistance which became positive at about 250°C.

Example 9

The solution consisted of 100 grams tin chloride, 4 grams antimony chloride, 4 grams bismuth chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 88.6 per cent $SnO_2$, 5.3 per cent $Sb_2O_3$ and 6.1 per cent $Bi_2O_2$. The fourth order film had a slight brown tint and an electrical resistance of 36 ohms per square and a negative temperature coefficient of resistance which changed to positive at about 150°C.

Example 10

The solution consisted of 100 grams tin chloride, 4 grams antimony chloride, 6 grams bismuth chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 86 per cent $SnO_2$, 5.1 per cent $Sb_2O_3$ and 8.9 per cent $Bi_2O_3$. The fourth order film had a brownish tint and an electrical resistance of 75 ohms per square.

Example 11

The solution consisted of 100 grams tin chloride, 2 grams antimony chloride, 8 grams cobalt chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 91.4 per cent $SnO_2$, 2.7 per cent $Sb_2O_3$ and 5.9 per cent $Co_2O_3$. The fourth order film was colorless and had an electrical resistance of 32 ohms per square and a positive temperature coefficient of resistance.

Example 12

The solution consisted of 100 grams tin chloride, 4 grams antimony chloride, 1 gram zinc chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 93.2 per cent $SnO_2$, 5.5 per cent $Sb_2O_3$ and 1.3 per cent ZnO. The fourth order film was blue to transmitted light and had an electrical resistance of 31 ohms per square and a positive temperature coefficient of resistance.

A fourth order film was obtained with the same composition; this was applied to a 2-inch square plate (high silica). The film had an electrical resistance of 42 ohms per square. When an A.C. equivalent to 300 watts at 110 volts was passed through the film for a few minutes its temperature, as measured by an optical pyrometer, rose to 825° C. and its electrical resistance increased to 56 ohms per square. On cutting off the current and cooling to room temperature, its resistance reverted to about 42 ohms per square. Seven cycles of heating by passage of current followed by cooling to room temperature caused no substantial change in the respective resistances and other properties.

Example 13

The solution consisted of 100 grams tin chloride, 1 gram antimony chloride, 1 gram iron chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 98 per cent $SnO_2$, 1.4 per cent $Sb_2O_3$ and .6 per cent $Fe_2O_3$. The fifth order film was colorless and had an electrical resistance of 28 ohms per square and a zero temperature coefficient of resistance.

Example 14

The solution consisted of 100 grams tin chloride, 2 grams bismuth chloride, 4 grams cobalt chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 94.1

per cent $SnO_2$, 2.8 per cent $Sb_2O_3$ and 3.1 per cent $Co_2O_3$. The fourth order film was colorless and had an electrical resistance of 24 ohms per square and a positive temperature coefficient of resistance.

Example 15

The solution consisted of 100 grams tin chloride, 1 gram antimony chloride 8 grams nickel chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 92.5 per cent $SnO_2$, 1.4 per cent $Sb_2O_3$ and 6 per cent $Ni_2O_3$. The fourth order film was colorless and had an electrical resistance of 45 ohms per square.

Example 16

The solution consisted of 100 grams tin chloride, 1 gram bismuth chloride, 1 gram thallium chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 97 per cent $SnO_2$, 1.4 per cent $Sb_2O_3$ and 1.6 per cent $ThO_2$. The third order film was colorless and had an electrical resistance of 18 ohms per square, and a positive temperature coefficient of resistance.

Example 17

The solution consisted of 100 grams tin chloride, 1 gram antimony chloride, ½ gram copper chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 97.9 per cent $SnO_2$, 1.4 per cent $Sb_2O_3$ and .7 per cent CuO. The fourth order film was colorless and had an electrical resistance of 25 ohms per square and a positive temperature coefficient of resistance.

Example 18

The solution consisted of 100 grams tin chloride, 1 gram bismuth chloride, 4 grams chromium chloride, 50 c.c. water and 10 c.c. hydrochloric acid, equivalent to 94.4 per cent $SnO_2$, 1.4 per cent $Sb_2O_3$ and 4.2 per cent $Cr_2O_3$. The fourth order film was colorless and had an electrical resistance of 18 ohms per square and a positive temperature coefficient of resistance.

All of the foregoing conductive (electrical) films have good chemical stability and their electrical properties undergo little, if any change under adverse conditions. This is demonstrated in the following examples.

Example 19

A sheet of borosilicate glass was provided with platinized strips along two opposite edges so that the surface area between the stripes was 3 inches square. The plate was then irridized with the solution shown in Example 12 until an irridized film was 39 ohms square. The film was heated for 100 hours at a temperature of 350° C. by passing through it an A.C. equivalent to 10.8 watts per square inch at an applied voltage which was varied between 61 and 63 volts in order to maintain constant wattage. At the end of this time the resistance was 38 ohms per square.

Example 20

An irridized glass plate similar to that described in Example 19 was tempered in known matter, after irridizing, by heating it to a temperature between its strain and annealing points and thereafter quenching it with a stream of cold air. The glass was then heated for 494 hours at a temperature of 400° C by passing through the film an A.C. equivalent to 14.2 watts per square inch at 63 to 66 volts. The initial electrical resistance of the film at 400° C. was 34.2 ohms per square. After 110 hours the resistance was 31.4 ohms per square and at the end of 494 hours the resistance was 32.6 ohms per square. The slight decrease in resistance was caused by the stabilization of stresses induced by the film, by tempering. Once stabilized, the resistance remains substantially constant.

Example 21

A tempered irridized glass plate similar to Example 20 was heated at 350° C. by passing through the film an A.C. equivalent to 10.8 watts per square inch. After the electrical resistance had become stabilized at 36.7 ohms per square the film was heated for 2 hours at 350° C. then cooled and exposed for 30 minutes to live steam after which it was again heated for 2 hours at 350° C. as before. Alternate heating and steaming were continued for 21 cycles after which the resistance was found to be 38 ohms per square.

Example 22

A tempered irridized glass similar to that described in Example 20 was heated to 350° C. by passing through the film an A.C. equivalent to 10.8 watts per square inch. After the electrical resistance had become stabilized at 33.9 ohms per square, the plate was cooled to room temperature and the irridized film was smeared with the cooking fat known as "Crisco" which was burned off leaving a slight carbonaceous residue. The glass was again cooled and the film was again heated for about 30 minutes to burn off the "Crisco". After 42 cycles of alternate greasing and burning off the resistance measured 33.9 ohms per square.

Example 23

A tempered and irridized glass such as is described in Example 20 was treated by alternately greasing it and burning off the grease as in Example 22 with the exception that after each burning off the carbonaceous residue was removed from the irridized film with the scouring cleaner "Bon Ami" before the film was regreased. The heating temperature was 350° C. The stabilized initial resistance at 350° C was 32.2 ohms per square. After 47 cycles of alternate greasing, burning off and scouring the resistance measured 32.2 ohms per square.

Tin-Antimony films have good chemical stability and their electrical properties undergo little, if any, change under adverse conditions.

Fischer adds antimony compounds to tin chloride solutions as previously described, and he finds that with the films formed the electrical resistance drops from 200 ohms to 20 ohms. He also finds that by adding aluminum chloride to tin solutions the film resistance increases.

Glass surfaces are treated with tin chloride vapors at 600 to 800 deg. An irridization film resulted. After 1015 seconds the film was 100 to 120 mu thick and interfered with light rays.

(*Continued on page* 706)

# Pacific Coast Regional Meeting

**A Review of the Glass and Refractories-Glass Papers Presented at the 10th Pacific Coast Regional Meeting of the American Ceramic Society**

On October 17, over four hundred ceramists, wives, and students gathered at the Sheraton-Palace Hotel in San Francisco for the Tenth Pacific Coast Regional Meeting of the American Ceramic Society—evidence of the steady growth in interest and members over the past years. It was stimulating to see the representation from the eastern United States as well as the great number of students from the various Pacific Coast schools. The Universities of Washington and California had especially large student delegations.

Professor R. M. Fulrath, University of California, Berkeley, was general chairman of the meeting, the success of which was due largely to his efforts as well as those of the various regional committee members, some of whom are listed below:
Section Chairman:

J. C. Swearengen, United Can and Glass Company, Hayward, Cal. Papers Chairman: R. Davies, Jr., General Refractories Company, San Francisco, Cal. Basic Science and General Interest: Dr. J. A. Pask, University of California, Berkeley, Cal. Refractories: G. E. Sievert, Gladding McBean & Co., San Francisco, Cal. Structural Clay Products and Whitewares: A. Wild, Kraftile, Niles Cal. Glass: George Loeffert, United Can and Glass, Hayward, Cal. Elec. Ceramics Symposium: L. A. LaForge, Sylvania Electric Products, Inc., Mountain View, Cal.

Publicity: M. Schmidt, Kaiser Aluminum and Chemical Corp., Oakland, Cal. Registration: J. T. Elmer, Kaiser Aluminum and Chemical Corp., Oakland, Cal. Field Trips: Dr. A. W. Searcy, University of California, Berkeley, Cal. Section Secretary: D. A. Bussey, Kaiser Aluminum and Chemical Corp. Refractories Division, Moss Landing, Cal. Section Treasurer: R. R. Riley, Gladding, McBean, and Company, Box 630, Pittsburgh. Ladies Program: Mrs. R. Davies and Mrs. R. M. Fulrath.

San Francisco, one of the most cosmopolitan cities in America, was an ideal setting for such a meeting and all its famous attractions, such as the Golden Gate Bridge, Chinatown, Fisherman's Wharf, cable cars, and Market Street merely added to the interest of the convention goers to make the meeting a most gratifying one. Another gratifying factor was the increasing interest in glass evidenced in the Bay area. Numerous container glass plants, serving the packing industries nearby and the expanding building industry of the West Coast, provide ample markets for glass products.

Dean John F. McMahon, State University of New York, College of Ceramics at Alfred Universtiy, opened the meeting with a welcome from the national society. Dean McMahon is president of the American Ceramic Society. C. W. Planje, president, Gladding, McBean and Company, Los Angeles, California, spoke on "A Decade of Progress for the Ceramic Industry," a subject which served as a theme for the entire meeting which emphasized the remarkable progress of glass and ceramics on the West Coast. Mr. Planje stressed the fact that there was a remarkable change in the technology and development of ceramic products at the end of World War II. The impact of foreign competition as well as the effects of other industrial products, such as plastics, served to influence profoundly the industry. A reawakening or renaissance took place.

Major developments since World War II were given as follows: 1) professional management by team methods rather than individuals, 2) inducement of young men to enter the field by means of scholarships and summer work, 3) broader use of technical knowledge, 4) interchange of scientific data and ideas through technical meetings and professional societies, and 5) broader use and application of market research to provide a wider application of existing products.

Predictions were made of the things to come as we now enter the second decade of atomic power, jet propulsion, and space travel—all of which will be enhanced by the use of glasses and ceramics.

The next speaker, Dr. W. Shockley, Shockley Semiconductor Laboratory of Beckman Instruments, Inc., Mountain View, California, gave a highly interesting explanation of the fundamental principles involved in "Semiconductors" and how they function.

The principle semiconductors in use today are germanium and silicon, both of which have a valance of 4. The structure and atomic bonding are highly important with the mechanism of electron refraction being likened to light refraction. The influence and modifying effects of such additives as arsenic, gallium and lithium were discussed. The use of all semiconductor devices involves the use of compensators that alter the characteristics of the crystal. The growing of single crystals was shown, and the effects of dislocation and imperfections at grain boundaries were also presented. The function of the semiconductor was also likened to conductivity of various salts in aqueous solutions.

The interesting explanation of a very difficult subject was highly appreciated and well received. Dr. Shockley, who is a Nobel Prize winner, made the subject most absorbing.

Wolfram Seitz, Glass Containers Corporation, Antioch, California, was session chairman of the glass division. The first paper presented Wednesday afternoon was "Pyroceram—A Family of Crystalline Materials Made From Glass," by S. Donald Stookey, Corning Glass Works, Corning, New York. Dr. Stookey described the properties of Pyroceram, a new material developed by Corning Glass. Pyroceram is a trade name given to a new line of materials more aptly called glass-ceramics.

The essential process is to melt special batches at conventional glass-melting temperatures and form shapes by one or more of the usual glass forming processes,

after which crystallization is deliberately controlled by prescribed heat treatment. The process has been studied by controlling the rate of crystal growth and the rate of nucleation, that is, the rate of formation of nuclei in vitreous media. The essential features are to keep the crystalline phases in solution during working and then precipitating many minute crystals (1-2 microns or less in diameter) during controlled cooling.

A wide variety of latitude is possible in size and shape of the articles made, and, in general, those processes that are applicable to glass processing may be employed.

The second paper of the afternoon session was "Some Factors Related to the Surface Structure and Durability of Glass" by H. E. Simpson, State University of New York, College of Ceramics, at Alfred University.

There has been a long-recognized need for a test that will evaluate the deterioration of glass surfaces. All glass products are subject to attack by chemical action in varying degrees.

Attack by moisture is initially manifested by a slight dimming or iridescence over the surface, followed by the formation of a noticeable film or even a heavy white scum in varying degrees and patterns, depending upon atmospheric conditons and the composition of the glass. This resistance to surface deterioration is important when one considers the unfavorable conditions of storage in unheated warehouses in northern climates or the hazards of shipping and storage in tropical climates where the humidity is excessive. The need for a laboratory method that will permit evaluaton of surface durability with reasonable precision is a prerequisite in developing glasses of greater surface resistance to weathering, whether by chemical composition or by surface treatment.

Previous work has indicated that the surface durability of the inside surface of a bottle is not quite as good as the outside of the same container. The reasons for this apparent difference are not exactly known but in the forming of a bottle, the outside surface comes in direct contact with the metal mold surface and some chilling may take place. On the other hand, the inside surface of the container, during forming, is blown or is in contact with gas under pressure that provides the blowing or forming mechanism. Previous tests were carried out on small sections of the walled surface of the container that had been previously cut out by use of a hot-wire technique. Such tests have been found to be useful in comparing the surfaces of different container compositions but the fact that the container itself had been destroyed failed to provide information concerning the durability of the surface of the container itself. In other words, it is highly desirable to know what effect the shape, contour and "finish" may exert on the general problem of durability. It has been realized for some time that the construction or opening at the top of the container may very well seriously influence the durability of the container. It therefore became necessary to test unbroken bottles or the container as a unit by means of the cyclic humidity test. Samples were then cut from the wall surface of such exposed containers, and plastic replicas were taken of the inside and outside surfaces in order that haze meter determinations could be made. After a series of exposures of bottles themselves in the cyclic humidity test ranging from 3 to 30 days or more, haze meter curves were prepared showing the relative deterioration of both inside and outside surfaces. Such tests have the decided advantage of indicating the expected durability of the product and therefore are of interest to the producer, seller, and user of such products.

The identity of the various decomposition products as revealed by the electron micrographs is not specifically known. From the haze meter curves the glasses of poor durability appear to show a marked increase in haze after 5 to 10 days' exposure in the cyclic humidity cabinet, with the breakdown being definitely associated with the pronounced break or vertical slope of the haze meter curves.

Perhaps the breakdown of a glass surface is associated with the adsorbed moisture film on the surface of the glass which in due time penetrates the surface in a rather selective manner, and an alkaline silicate of some type is ultimately formed.

The container glass containing high $Al_2O_3$ showed remarkable resistance to attack by moisture after 30 days' exposure. From examination of the electron micrograph the surfaces appeared to be smooth, and moisture apparently had not gained a foothold for selective action. This reaction is quite in contrast to that shown by a normal soda-lime-silica composition in which definite etching is evidenced after only 3 days' exposure. Iler, in his book, "The Colloidal Chemistry of Silica and Silicates" has pointed out that $Al_2O_3$ tends to shield or repel the OH groups from the surface of glass, and therefore one would expect less attack. It would appear that by means of a combination of controlled deterioration, brought about by the use of the cyclic humidity tests, glass surfaces may be weathered to any desired stage, and that by means of the replica technique for electron microscopy an enlarged view of the destruction of the surface may be studied. It is therefore hoped that by a combination of these techniques, a better knowledge of not only the durability but also the chemistry of the surface of glasses may be revealed.

The next paper, "Major, Minor, and Micro Inhomogeneity in Glass",* was written by Larry Penberthy, Penberthy Electromelt Company, Seattle, Washington, and was presented by George Loeffer, United Can and Glass, Glass Division, Hayward, California.

Bottles are being made in large tonnages today from glass of optical homogeneity, the glass being made in all-electric tanks. The results have been so outstanding in yield and service performance that it is worth while to consider the methods by which fuel-fired bottle glass can be upgraded to this degree of homogeneity.

The author first considered major inhomogeneity. This type of inhomogeneity was defined as being caused by broad variations in the raw materials used in the batch, and variations in the batch composition from batch to batch and day to day. The dimensions of such inhomogeneity would be measured in feet, meaning that a batch put in the furnace in the afternoon is 10 or 15 feet away from a batch put in in the morning.

There are several sources of major inhomogeneity that every plant is aware of, and is constantly alert to guard against, such as variations in the oxide contents of the raw material and errors in batch weighing.

*This same paper was presented by Mr. Penberthy at the Glass Division Meeting in Bedford Springs, Pa., and reported elsewhere in this issue.

Window glass producers traditionally use very large and deep tanks, and exert themselves to maintain a strong and well developed convection current in order to fight major inhomogeneity. It is estimated that the tonnage of glass participating in the convection current is ten times as great as the glass drawn through machines. It is not uncommon for the dead weight of glass in such a furnace to be seven times as great as the daily draw. By contrast, bottle furnaces often have a dead weight only one or two times the daily draw.

There is another source of major inhomogeneity in the nearly-dormant layers or pockets of glass in the lower levels, dead corners, or in the working end. In one tank which was making heat absorbing glass, the lower levels were so cold that they were devitrified and motionless, most of the time. Occasionally, following changes in the pull or the firing, enough of this dormant glass came to the surface and went into the stream to the machines with decidedly unhappy results.

The working end has been criticized as an adverse factor with respect to homogeneity for more than twenty years. It was pointed out in a paper by Preston in 1936 that the convection currents in a working end which is large and deep are sufficiently slow so that some of the glass which was made from batch introduced last week is still present to mix partially with the glass which was made only a few hours before. These two glasses inevitably differ from each other, as evidenced by the sawtooth variations in the density chart from day to day, with resultant deterioration of the homogeneity.

Several furnace engineers over the past number of years reported good results with working ends so small that they are no more than distribution channels. The latest all-electric furnaces that have such high homogeneity have no working end at all. The glass flows in a continuous manner from the throat to the machines in less than one hour.

Minor inhomogeneity has its source in the nearly-inevitable inadequacy of batch mixing, in segregation during transport of the batch, in segregation during the melting process itself, or in the dissolving of refractories by the glass. Mixing is not absolutely perfect, and the silica content of the batch could vary by at least several percentage points within a distance of a few inches. Also, in the melting of a batch pile, the fluxes melt and flow down the side, combining with only part of the silica as they go. In this way, the last of the batch pile is a little higher in silica, adding to the variation of the silica owing to the inadequacy of mixing. Thus the dimensions of minor inhomogeneity are in inches.

However, the normal furnace does not have any means for raising the homogeneity to the optical glass level. Turbulence on the inches scale is required. This can be provided in several ways, such as by electrode heating, bubbling, or mechanical stirring. While convection currents by definition are turbulence, convection flow is laminar when dimensions of inches are considered. The methods suggested can produce turbulence of the small size required.

Mechanical stirrers are being used in the forehearth with beneficial results. However, these beneficial results are judged to be due to the uniform redistribution of the cords rather than by their elimination. The best place to make the glass homogeneous is in the melter where the temperature is highest and the viscosity lowest.

Micro inhomogeneity is due to the grain size of the materials used. Even at the melting temperature glass is still a relatively viscous liquid, and in a small space the flow is quite laminar. It is true that the initial bubbling resulting from decomposition of the carbonates agitates the liquid matrix so that the low-melting-temperature liquids are reasonably homogeneous. However, the residual sand grains normally are not subject to such agitation. They go into solution rather slowly, and are quite liable to be carried through into the ware before their skeleton structure is eliminated. Various investigators have reported on this skeletal structure which remains from the sand grains even after they have become completely transparent and apparently fully dissolved.

The use of unusually fine materials can go far in elimination of micro inhomogeneity. In some optical glass making, very finely powdered materials are used in the batch which is mixed, pulverized, and then remixed. The appearance of melting from such an intimate mixture is quite different from that where the grain sizes are larger or the mixing not so thorough. Eutectics form much faster, and no batch stones can be found.

It is not economical to use superfine materials for bottle and window glass. Instead, micro stones can be eliminated by time and temperature or by electric melting. It is reported that the sand grain skeleton breaks down after approximately eight hours at melting temperatures. Thus, it is necessary to make certain that the convection current keeps the batch piles from getting close to the throat. Additionally, this skeletal structure can be eroded away more rapidly when electric melting is used. The theory is that the sodium ion is moving back and forth under the influence of alternating current far enough and often enough to have considerable erosion effect on the micro structure. This sodium ion is estimated to move a distance in the order of one ten-thousandth of an inch per half cycle. There are eight million of these movements in eight hours, so that it is reasonable to assume that this erosion effect is quite powerful.

A paper, "Determination of Several Valences of Iron, Arsenic, Antimony and Selenium in Glass" by Paul Close, C. H. Drummond, and H. M. Shepherd, General Research Division, Analytical Chemistry Laboratory, Owens-Illinois Glass Company Technical Center, Toledo, Ohio, was presented by Frank C. Raggon, Chief Chemist, Owens-Illinois Pacific Coast Division.

In this paper there were described methods for determining ferrous iron; triand pentavalent arsenic and antimony when present together; and selenium as $Se^{-2}$, $Se^{0}$, $Se^{4+}$, and $Se^{6+}$ in silicate glasses. While the basic methods are fundamental in analytical chemistry, the techniques employed were somewhat unusual. In particular, the direct use of a hydrofluoric acid solution of glass is uncommon and yet, if handled properly, can simplify what otherwise may be a cumbersome and lengthy analysis.

The method described for determining ferrous iron involved the solution of glass in hydrofluoric and sulfuric acids in an atmosphere of $CO_2$. After the hydrofluoric acid had been complexed with boric acid, the ferrous iron was determined by titrating the solution with a standard ceric sulfate solution using ferroin as an indi-

cator.

Trivalent arsenic and antimony were determined by dissolving a sample of glass in hydrofluoric and perchloric acids. Then after the hydrofluoric acid had been complexed with boric acid, the solution was titrated in a plastic beaker with ceric sulfate, using ferroin indicator and osmium tetroxide as a catalyst. Total arsenic and antimony in the glass was determined by dissolving a sample in hydrofluoric, perchloric, and nitric acids. The arsenic was then reduced to the trivalent state and separated by distillation. The antimony was recovered as the sulfide. A third sample was treated similarly, but without the addition of nitric acid. After volatilization of the trivalent arsenic as the fluoride, the pentavalent arsenic was reduced and separated by distillation.

The method for determining total selenium in glass involved solution of a suitable sample in hydrofluoric acid and a mixture of hydrobromic acid and bromine water. After reduction of the excess bromine with formic acid, the solution was titrated potentiometrically with sodium thiosulfate and iodine. In the determination of quadravalent selenium, the sample was treated in a manner similar to that of total selenium except that the hydrofromic acid-bromine mixture was omitted, thus permitting the hexavalent selenium to be separated subsequently as the acetate. Another sample was prepared the same way as the sample for quadravalent selenium except that the precipitation of the hexavalent selenium as the acetate was omitted. After separation of the elemental selenium by filtration, the combined quadravalent and hexavalent selenium was determined in the filtrate by titration with sodium thiosulfate. The elemental selenium was then dissolved and determined by titration. Still another sample was treated in a special apparatus with hydrofluoric and hydrochloric acids in the presence of zinc. The hydrogen selenide evolved was absorbed in an alkaline solution and subsequently oxidized with bromine and then titrated.

In presenting these procedures, it was the author's aim to show that the chemical analysis for the different valence states of certain glass components is feasible. It is felt such information will be an aid in the study of color and oxidation-reduction equilibria in glass.

The last paper presented in the glass division on Wednesday afternoon was, "Gas Boosted Electric Furnace," by Allen J. Erickson, Northwestern Glass Company, Seattle, Washington. Mr. Erickson presented a most interesting paper describing the operation of an electric fired glass container furnace. This furnace was initially operated by electric firing alone utilizing submerged molybdenum electrodes. An unmelted glass batch of 12-15 in. over the surface of the glass melt provided sufficient top insulation to eliminate the normal superstructure of the tank.

It was desired to increase the daily pull of the tank from 32 to 45 tons, and gas boosting of the otherwise electric melting procedure was employed. A crown was installed over the melting end of the tank and sufficient temperature maintained by gas firing above the melt to provide the extra melting capacity desired. The actual surface temperature of the glass was about 2350°F, while the glass melting temperatures below the surface were close to 2650°F.

This novel procedure of melting has provided numerous melting advantages such as low stone count, good homogeneity, less selenium loss, and a higher percentage of first quality ware. While the increased tonnage of 42 tons per day was attained, the repair of the furnace was effected in only 13 days.

Many details of the furnace construction, which was of the Cornellius design, were given. The gas boosting has permitted a campaign of 30 months utilizing 5 sq. feet per daily ton pull. There are many economies realized in this practice, and Mr. Erickson and his coworkers are to be congratulated on devising a very novel and ingenious method of glass melting that has reversed the normal concept of industrial melting, namely, gas boosting of electric melting.

A highly informative group of papers, devoted to the general subject of Refractories and Glass, was presented Friday afternoon. The first paper, "Some Trends in Refractories for Glass Furnaces," by G. B. Massengale and C. F. Wenrich, Harbison-Walker Refractories Company, San Francisco, California, was presented by Mr. Wenrich. The general classification of refractories considered was silica, high-alumina, corundum and basic types.

The importance of high purity silica brick in superstructures was stressed, and the effects of small amounts of impurities, such as $Al_2O_3$ and alkalies, were especially emphasized. Boring caused by volatilization of alkalies from the glass batch was pointed out as being most objectionable.

Alumina-silica and more recently the high-alumina hot cast refractories were cited as being the most desirable below the glass line. The use of basic brick in checkers and regenerators was emphasized, especially where the erosion caused by alkalies was particularly severe.

The use of castables in flue arches was illustrated and highly recommended. In addition, the general use of insulation was also discussed. Insulation was recommended in the crowns, checkers, flues, side walls, and, in some instances, bottoms of the tank.

The paper was an excellent indication of present-day trends in the application of refractories in glass making.

The next paper presented was "Phosphate Bonded Castable Refractories" by H. D. Sheets, J. J. Bulloff, W. H. Duckworth, Battelle Memorial Institute, Columbus, Ohio.

Conventional refractory castables—those bonded with a calcium aluminate cement—are limited to maximum temperature use, not by the refractoriness of the aggregate but by that of the cement. For many years, ceramic technologists have been intrigued by the problem of developing a castable whose refractoriness is essentially that of the aggregate. One possibility that has been suggested is to bond with a phosphate, from which phosphorus would volatilize at a sufficiently high temperature and leave no fluxing ingredient.

There is no doubt but that the mechanism of phosphate bonding is complicated. However, a thorough understanding is necessary before the optimum bond can be developed and before apparent inconsistencies can be explained.

To describe the bonding action as a simple acid-base reaction where $H_3PO_4$ reacts with $Al_2O_3$ or $Al(OH)_3$ in the presence of $H_2O$ to form $AlPO_4$ is certainly oversimplifying the situation.

Some 15 different phases of hydrated aluminum phosphates have been detected so far, and indications are that vitreous rather than crystalline forms may be involved as intermediate steps in the development of the bond.

$AlPO_4$, which undoubtedly is present, exists in 6 crystalline forms paralleling the alpha and beta forms of quartz, tridimite, and crystobalite. It is well know that $SiO_2$ can form large chain, net, and sheet structures, and that such structures are strong, cohesive, and high melting. $AlPO_4$ may behave in a similar manner. The following theory of bonding is proposed.

Initially, a trivalent phosphate anion is present. As the mixture dries and as the acid reacts with the alumina, covalent polymerization occurs. This polymerization results in bivalent $PO_4$ units which become "ends" in chain polymerizations. Two of these then fuse to form a tetravalent pyrophosphate.

As the reaction proceeds, $PO_4$ units form with only one formal charge remaining. These units may be called "middles". One unit, terminated by two of the previously formed "ends", results in a family of linear polyphosphates.

The next step in the development of the bond comes from $PO_4$ groups having no formal charge but capable of forming "branches". Branching, such as is proposed in this paper, could give rise to a sheet structure.

The aforementioned, "ends", "middles", and "branches" involve only the phosphorus and oxygen atoms. To explain the unusual properties of phosphated-bonded alumina, one would expect the Al atom to become involved in these reactions. Structural chemists believe in the formation of "super branches" which are capable of three-dimensional growth. Thus, phosphate bonding can be viewed as a hetropolyanionization process leading to the formation of strong oxygen polyhedral structure.

If this picture of the bonding mechanism is correct, many factors may influence the bonding reactions. Water content of the original batch, availability of the aluminum cation, temperature and rate of drying, and the presence of impurities all can be expected to influence the strength of the bond.

True refractory castables prepared from alumina, mullite, beryllia, zirconia or silicon carbide grog bonded with phosphoric acid or aluminum phosphate were formulated. The use of Rodine, a complex amine which inhibits reaction between metallics and the acidic agent, and ammonium fluoride, which accelerates setting of the castables increased the usefulness of phosphate-bonded compositions.

The next paper presented was "Manufacture of Fused Cast Refractories," by Roy W. Brown, The Carborundum Company, Refractories Division, Perth Amboy, New Jersey.

Mr. Brown showed many slides illustrating in detail all phases of manufacture of the unique electric furnace fusions of these interesting modified products of alumina, zircon, and chrome. The raw materials used in Type H, Type S, Type M, and Type K refractories were first described.

The numerous problems encountered in the use of three phase electro-melt furnaces utilizing carbon electrodes and extremely high temperatures for melting were discussed. Shapes were cast in graphite molds employing an extremely large header in order to provide the maximum homogeneity in the bulk of the shapes. The annealing process which followed was carried out by means of insulated bins that permitted slow cooling of the cast shapes.

The annealing process is highly important to the control of the crystalline structure of the refractory as well as that of the glassy bond which holds the crystals together. After proper annealing, each shape is cleaned, weighed, and marked for shipment.

Some excellent colored slides were shown illustrating the preferred structure desired in the various products. The petrographic thin sections which made the slides possible, have been of extreme value in improving the use of the different products for glass manufacture. The general applications of the improved refractory products were discussed in this most informative paper.

A paper was given by Harold W. Bague, Corhart Refractories Company, Louisville, Kentucky, on "How Refractories Have Met the Furnace Problems of the Glass Industry."

The trend toward modern refractories is synthesis of raw materials to make a product of custom properties. With the design of the first continuous or tank type furnace in 1880, refractories suddenly had to undergo a major change.

Clay blocks were eventually developed and came into general use. They have changed little over the last 50 years.

In the early twenties, Corning Glass works reasoned that the most resistant composition would be of alumina and silica. Electric melting and recrystallization offered an interesting solution and a progressive step. These refractories were good but expensive.

Later, refractory producers approached the problem by the use of mullite or sillimanite compositions. These refractories were not very successful when in contact with glass but proved to do an excellent job above the glass line. Hence, sillimanite replaced silica to a certain extent as an upper structural material and at the same time, fused cast block were replacing clay block below the glass line.

As better refractories were being used, furnace life was extended and the rate of pull of the furnace increased. The demands on furnace refractories increased. Fused cast refractories were extended to upper structures as well. Sillimanite in turn began to replace firebrick, silica, and super-duty brick in port necks, regenerators, and checkers.

As furnace life was extended from one year to two, then three and finally four years and longer, checkers became an ever increasing problem. Basic brick were finally found to be an answer to this problem and were tried because of their success in the steel industry.

Today, the glass industry is becoming a specialized one with each division offering unique problems; e.g., fiber glass operations with its special compositions has found dense zircon and bonded chromic oxide to be most useful, while optical glass has found dense alumina materials to be the most useful.

Refractories of the future will be more expensive; they will last longer, provide better insulation, and be freer from tendency to cause stones, cords, blisters, or color the glass.

The next paper given was "A Study of Basic Magnesium Sulfates", by Alan J. Mennie and Alan W. Searcy, University of California, Berkeley, California. The paper was presented by Mr. Searcy. This paper was a fundamental study of a portion of the magnesium sulfate-magnesium oxide-water system. The study was carried out by X-ray diffraction and differential thermal analysis. One ternary phase was found, and its thermal dehydration and decomposition were investigated. Two phases, hydrated hydroxy and magnesium oxysulfate, may be present.

Magnesium sulfate solutions are used to bond MgO; hence the results may be of practical value in explaining the intermediate bonding agents effective in magnesite brick. This work of Searcy and Mennie is an example of the benefits derived by industry from fundamental or "know why" studies. Such studies are highly desired and should be encouraged.

The last paper presented in the Refractory Division was "Zircon Refractories for the Glass Industry," by Everett A. Thomas, Chief Ceramic Engineer Research and Development, Charles Taylor and Sons Company, Cincinnati, Ohio.

During the past two years, extended applications of zircon refractories have been most favorable, resulting in more interest in the use of this type of refractory. It is thus the purpose of this paper to report on new developments and applications in this field.

Zircon refractories have met with good acceptance throughout the glass industry. With present trends toward longer furnace life, higher rates of pull and better quality glass, the increased use of standard and dense grades of zircon are now becoming more justified. It is expected that new developments in zircon type refractories will partially fulfill the demands of the glass technologist in years to come.

Many furnace operators are of the opinion that the forehearth of the tank should be constructed of super quality material having good erosion resistance and high purity, for stones, seeds, alumina cords and glass discoloration introduced at this point cannot be easily cleared up. Zircon refractories are considered in this class since they are processed from high purity raw materials, have excellent resistance to opal and borosilicate glasses, and are not a source of alumina cords. Orifice rings, feeder spouts, and tube seat inserts have been supplied in standard zircon for the past 15 years for use on these glasses. It was, in fact, the success of these shapes which later paved the way for more extensive tests and application of zircon in the glass tank.

The initial use of zircon tubes and plungers did not prove successful owing to thermal cracking on installation in a hot forehearth. With the development of zircon shapes having improved thermal shock resistance, the application of zircon tubes and plungers has now shown outstanding results with service life running 3 to 4 times that of mullite or sillimanite shapes in opal and borosilicate glasses.

Standard zircon feeder parts have not been considered satisfactory on flint glass because of the prevalence of seeds; however, recent tests have shown that the dense grade of zircon has excellent erosion resistance to flint glass in the feeder and does not produce seedy glass. Dense zircon tube seat inserts, have given twice the life of sillimanite and appear equal to fused cast inserts.

The use of dense zircon spouts is now preferred over standard zircon for use in opal and borosilicate glass, and tests results have been very favorable using dense zircon rectangular shapes as built up channels on flint, opal, and borosilicate type glasses.

The results to date have shown that zircon forehearth and expendable feeder shapes do contribute to better quality glass and give longer service, thus reducing down time for replacement of feeder parts.

The Pacific Coast Section committee members and officers are to be congratulated for providing a most excellent and informative meeting and future meetings will be looked forward to with great anticipation.

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## HARSHAW IS HOST TO ACL DECORATORS

A meeting of ACL decorating supervisors was held in Cleveland November 3, 4, 5, 1957, at the Wade Park Manor Hotel under the sponsorship of The Harshaw Chemical Company. Twenty-one companies from the U. S., France and Peru were represented.

**At ACL decorating supervisors meeting were, from left: S. Gullo, Pepsi-Cola Company, New York; J. W. Iliff, The Harshaw Chemical Company, Cleveland; Paul Coiffe, Harshaw-Coiffe, Limoges, France; and L. England, Pepsi-Cola Company, New York.**

Mr. Fred Maynard led a discussion on camera equipment used in ACL departments and outlined details of a dark room camera which is inexpensive yet gives results comparable to very expensive equipment. The balance of the discussion the first day was informal and covered the general problems of the ACL decorators.

During the second day's meeting, representatives from the franchised beverage companies discussed their particular requirements in an ACL decoration. Testing and specifications were also covered and it was suggested that uniform specifications and test methods would be desirable in this field.

The ACL decorating supervisors decided to investigate the possibility of organizing into a permanent form and unanimously elected Mr. Francis Kay chairman.

Because of the need of this type of organization in the glass industry, it should be an outstanding success.

# Glass Furnace Repairs

**By CLINTON BALLINGER, Safety Director**
**Owens-Illinois Glass Company, Gas City, Indiana**

The following talk was given by Mr. Ballinger at the 45th annual National Safety Congress held by the National Safety Council at the Conrad Hilton Hotel, Chicago, Ill., October 21-25 of this year.

• A GLASS MELTING FURNACE is made of refractory and steel in different shapes. The area where the melting process takes place is shaped like a huge cave. The walls and floor are made of blocks of various refractory material, each block being 18 inches to 60 inches and 12 inches thick. The roof is also brick.

On each side of the melting area and connected to it are the checkers which serve as the passage way for the various types of fuel to flow to the tank to melt the batch to make the glass. The inside of the checkers are of brick laid to form a honey comb pattern. The checkers may be 30 feet high, 12 feet wide, and 25 feet long.

The plans to repair a tank evolve when the tank is built. The first step to repair a tank is to drain the tank of several hundred tons of molten glass. A special block is built in the tank for this purpose. A hole is knocked in this block and the molten glass runs into a stream of cold water which carries it several feet outside the building to a prepared bin for storage.

While the tank is being drained, the heat on the glass is about 2700° which insures a free flow of glass. About 12 hours are needed to drain a tank of 250 ton capacity. When empty all fires are turned off; the following day dismounting starts. But even then the tank proper is still very hot.

When a tank is out of operation for repairs, several men are out of their regular jobs. In our plant this means 20 to 30 men have to be placed on other jobs or laid off. Of course, these men have the least seniority and therefore are considered green help when put on a tank repair.

About one week before taking the tank out of operation, the plant engineer asks for 30 or 36 men to work with the regular maintenance crew. About three days before beginning work, we call a meeting to assign them to a shift and introduce their crew leader. Every type of safety equipment is shown, and when and where to wear it. They are also told if they can't wear this safety equipment someone will take their place.

One man of the group is designated as the safety and good housekeeping coordinator and reports directly to the plant engineer. This man has played a very important role in our safety record for the past several years by making it an important job to himself. He has the responsibility of checking out all safety equipment and also seeing that it is used properly.

When the time comes for dismantling the furnace, the checkers have been opened up. They have had time to cool off but are still pretty warm. The first step is to throw out bricks by passing from one man to another. The first few hours result in a lot of horse play as the bricks are hot and a man only holds a brick long enough to toss it to the next man. Since this can result in cracked shins and broken toes, it is one feature that must be watched — for the first day — until the checkers are cleared out or the bricks have cooled down.

After about three days of dismantling in which the work is hot, dirty and dangerous, the brick masons are called in and the building up process begins. There is still much dismantling to be done, but enough is completed for construction to start.

While this work is going on (on the tank proper), there are several other crews working, such as the electricians, plumbers, steel workers, tinners and machine repair men. Although these craftmen's work may be in different spots around the tank, they must know of the other work going on above them, below them and on either side of them. We are not too alarmed that a man throwing bricks will hurt himself but that someone else will catch the full force of a hastly tossed brick.

One of the big items on any repair is this thing called housekeeping. In every plant today it is stressed in many different ways to the employees. Many supervisors feel a good housekeeping program is lots of janitors and lots of brooms. But it's not. It is pride in the worker who wants to work in a clean place, and will do his part to keep his work area clean. This is a job for the supervisor and only the supervisor.

Many accidents are caused by poor housekeeping and little or nothing is done to correct the condition. When 50 to 75 men work in an area not much larger than a basketball floor, with many types of material and equipment, good housekeeping is a must. If you have a good housekeeping program you will likewise have a good safety program. Our last lost time accident on a tank repair was caused by poor housekeeping —a small piece of brick was lying on the floor (probably had been there for two or three days), a brickmason stepped on it, and broke his ankle.

To make safety more real to the average man, several methods or approaches can be used. Posters are the largest medium to preach safety. Supplementing the posters we have been using the give-away gimmick. After one full week of work on a tank repair, the names of all men working on the tank are put in a box. At the 3:00 p.m. coffee break, while the men are congregated in one area, one name is drawn out and this individual wins a small prize such as a jacket, pair of safety shoes or one of several items costing from 3 to 10 dollars. This gimmick has done more to promote safety on tank repairs in our plant than any other. Since the use of the give-away idea, we have not had a single serious accident.

Proper scaffolds are always a must and should be inspected before being used and very often after that. The use of high lift trucks to transport and elevate tank blocks certainly cuts the danger of smashed toes, fingers and back injuries. The payloader is a real asset in loading trucks of bricks torn out of the furnace.

Every saftey device and gimmick available should be used on one of the toughest jobs in the glass industry.

# Inventions and Inventors

## Annealing and Tempering

*Lehr for Ceramic Enameled Glass Bulbs. Patent No. 2,784,531.* Filed November 28, 1955. Issued March 12, 1957. Two sheets of drawings; none reproduced. Assigned to General Electric Company by Clarence E. Hahn.

The present invention relates to glass annealing lehrs.

Such lehrs are useful for fusing a coating of light-transmitting ceramic enamel to the exterior surface of glass bulbs, such as glass incandescent lamp bulbs, for example. Due to the large variety of sizes, shapes and wall thicknesses of glass incandescent lamp bulbs, the successful fusion of such coatings on bulbs of different physical characteristics in a single lehr has offered difficulties heretofore.

A feature of the lehr embodying the present invention is a readily adjustable airflow control means mounted in the path of a stream of heated air entering the part of the lehr whereat the fusion of the ceramic enamel coating on the bulb surface takes place, by which means the air-stream is first divided and then distributed along parallel runs of ware in the lehr, in such manner that by simple adjustment of the airflow control means, the lehr may be quickly adapted for processing a large variety of ceramic enamel coated glass bulbs of different sizes, shapes and wall thicknesses.

There were six claims and the following references cited in this patent: 1,766,545, Rendall, June 24, 1930; 1,838,143, Hoge, Dec. 29, 1931; 2,066,374, Walters, Jan. 5, 1937; and 2,120,947, Amsler, June 14, 1938.

## Feeding and Forming

*Take-Out for Glassware. Patent No. 2,783,589.* Filed June 9, 1952. Issued March 5, 1957. Two sheets of drawings; none reproduced. Assigned to Lynch Corporation by Robert F. Wiley.

This invention relates to a "take-out" for use in connection with glassware-making machines and particularly to the driving mechanism for the take-out so as to impart a variable speed thereto. In order for the ware to properly clear the mold during the take-out for which the present invention is applicable, the take-out is one of the "4-arm" type, although the driving mechanism disclosed can be designed for 2-arm and 3-arm take-outs as well.

The objective is to provide mechanism comprising a drive arm and a driven arm connected with the respective shafts and connected together by a pair of links which are pivoted to each other and provided with a roller at the pivot joint; a cam groove is provided in which the roller travels and which, accordingly, jack-knifes the links more or less to speed up or slow down respectively the driven arm with respect to the drive arm and thus the driven shaft with respect to the drive shaft. The driven shaft has the take-out arms mounted thereon.

There were four claims and the following references cited in this patent: 2,398,100, Lear, Apr. 9, 1946; 2,514,420, Shapiro, July 11, 1950; 2,555,117, Collins, May 29, 1951; and 2,589,852, Overacker, Mar. 18, 1952.

## Furnaces

*Method and Apparatus for Manufacturing Glass. Patent No. 2,773,111.* Filed July 1, 1952. Issued Dec. 4, 1956. One sheet of drawings; none reproduced. Assigned to Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Sain-Gobain, Chauny & Cirey, by Pierre Arbeit and Andre Mathey.

The present invention relates to an improvement in glass fining, especially in furnaces for continuous production.

The objects of the invention are accomplished by maintaining the atmosphere above the glass bath in the fining zone, at a temperature sufficiently low for lowering the temperature of the upper surface of the glass in the fining zone to a temperature at which the gases, discharged by the fining, congeal in bubbles on the surface and form a persisting layer of foam extending substantially throughout the upper surface of the fining zone; and, on the other hand, by creating a small, localized area or areas of more intense heat within the glass in the fining zone which will generate large, very hot bubbles which have sufficient ascending force to break their way through the bubble blanket floating on the glass, thus providing for the escape of gases at localized spots and preventing any undesired accretion to the bubble blanket. The foam blanket may be maintained at efficient insulating thickness by raising or lowering the temperature above the foam layer if required.

The fining of the glass in the furnace is carried out by means of heat applied to the interior of the glass in the fining zone, preferably by Joule effect generated by electrodes which pass current through the glass and are localized in the depth of the bath, and preferably, during the general operation of the furnace, by vertically arranged electrodes, preferably of rod type, which are submerged in the glass, and enter through the bottom of the furnace. The invention also contemplates that the presence of the foam layer shall not prevent the evolution of bubbles formed in the glass and rising to the surface, but that such small bubbles may be gathered under the foam layer, in the hot spots, until they form big bubbles having sufficient force to break their way through the foam layer and escape.

There were 13 claims and 16 references cited in this patent.

## Glass Compositions

*Glass Composition and Metal Coated Glass Fiber. Patent No. 2,772,987.* Filed November 7, 1952. Issued Dec. 4, 1956. One sheet of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Harry B. Whitehurst and William H. Otto.

The invention relates more specifically to metal coated fibrous glass materials.

Attempts have been made to provide glass fibers with a metal coating which completely surrounds each individual fiber and thereby protects it from adjacent fibers in a strand. The purpose is to increase the abrasion re-

sistance of the fibers to such a point that strands, yarns, and fabrics made from such fibers will show greatly increased resistance to abrasion, flexing, knotting, and other working which in the case of previously produced glass fiber textiles often was destructive.

A glass composition having the following ingredients in the weight percentages indicated is prepared in the conventional manner.

| | |
|---|---|
| $SiO_2$ | 56.9 per cent |
| $Al_2O_3$ | 5.4 |
| MgO | 2.5 |
| CaO | 6.1 |
| $B_2O_3$ | 6.4 |
| $Na_2O$ | 0.5 |
| $K_2O$ | 0.3 |
| SrO | 11.2 |
| CuO | 9.0 |
| $Li_2O$ | 1.7 |

This glass which has 9.0 per cent copper oxide has marked abrasion resistance and flex resistance and at the same time is a silica composition that is readily adaptable for being covered with metal coatings including those of zinc, tin, copper, aluminum, woods alloy, roses alloy, alloys of zinc and titanium, tin, silver, and the like. Furthermore, this glass is readily adaptable to be formed into individual fibers which can then be further processed into strands, cords or fabrics as may be desired. The strand, fibers or the like are easily coated with the above metals using vacuum apparatus conventionally used for applying metals.

There were 5 claims and the following references cited in this patent: 2,143,022, McClure, Jan. 10, 1939; 2,251,913, Brennan, Aug. 12, 1941; 2,491,761, Parker et al., Dec. 20, 1949; 2,500,092, Parker et al., Mar. 7, 1950; 2,562,182, Godley, July 31, 1951; 2,577,936, Waggoner, Dec. 11, 1951; 2,616,165, Brennan, Nov. 4, 1952; 2,685,526, Labino, Aug. 3, 1954; and 2,685,527, Labino, Aug. 3, 1954.

## Glass Wool and Fiber

*Consumable Glass Fiber Ingot Mold Liner. Patent No. 2,763,043.* Filed July 23, 1954. Issued Sept. 18, 1956. One sheet of drawings; none reproduced. Assigned to Lukens Steel Company, by Nicholas J. Grant.

This invention relates to the art of casting metal ingots by pouring of metal into molds and, more particularly, to improved means for facilitating the casting of steel ingots free from surface imperfections and defects.

The idea of putting a barrier or liner of some sort between the ingot mold wall and the metal stream entering the mold is to prevent splashing.

The barrier or partition should fuse or, in other words, the barrier should serve to prevent the splash from contacting the walls of the mold and to decrease or minimize the surging effects of the metals, and then melt away.

It should not leave a large amount of residue and a curtain of glass fibers. It is ideal in that the glass converts to a small quantity of fluid, liquid slag, which, because of its high fluidity, tends to stay in large lumps and therefore is not trapped in the ingot during pouring. These large silicate particles easily float out in the molten metal being poured.

The liner should be inorganic and have low vapor pressure, as it is undesirable to have gas generation which occurs from all carbon products such as tar or soot.

The barrier material should be non-reactive. Most oxides and silicates are quite stable at high temperatures and therefore do not react with the metal itself to form other products.

The barrier should be a poor conductor of heat.

The liner material should be relatively inexpensive and readily available and easy to install. Glass fibers used as a liner in ingot molds meet the above requirements ideally.

There were 5 claims and the following references cited in this patent: 1,678,976, Durfee, July 31, 1928; 1,859,355, Crowther, May 24, 1932; 2,273,543, Terrill, Feb. 17, 1942; 2,631,344, Kennedy, Mar. 17, 1953; and 626,906, Great Britain, July 22, 1949.

## Sheet and Plate Glass

*Corrugated Glass Sheets. Fig. 1. Patent No. 2,735,227.* Filed September 25, 1953. Issued February 21, 1956. Two sheets of drawings. Roger Guilleminot.

According to the present invention (See Fig. 1), the rollers 16 systemmatically receive the glass, the movement of which may be automatically controlled as a function of the forward movement of the chain 1 in conjunction with the elements controlling the rise and fall of the carriage 14.

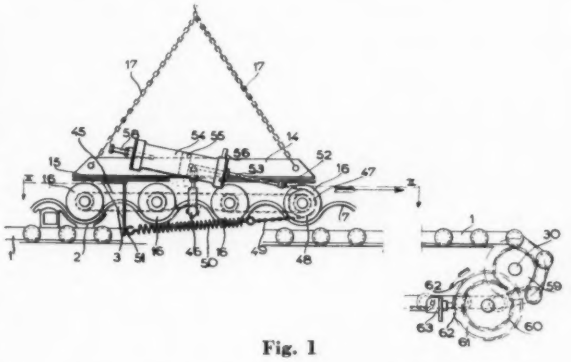


Fig. 1

To this end, the rollers 16, composed of tubes turning in the supports 15, carry on one side the toothed wheels 44, all these wheels 44 being connected together by a chain 45, for example of the Galle chain type. All the rollers 16 are thus rotated together and simultaneously turn through the same angle. A means of tensioning the chain 45 is provided at 46, fixed to the frame 14.

One of the rollers 16, for example, the last roller in the direction of movement of the chain 1, receives the rotational drive, which is transmitted to the other rollers through the chain 45. For this purpose, said roller carries at the opposite end to that provided with the wheel 44 a detent mechanism 47 similar to a freewheel in a bicycle. This freewheel is driven by a second toothed wheel 48, in turn driven by a chain 49. This chain is attached at one end to a return spring 50 fixed to a bracket 51 secured to the frame 14. At the other end it is attached at 52 to the rod 53 of a compressed air driving means 54. The device 54 consists, for example,

of a cylindrical casing in which a piston 55 moves, to which the rod 53 is fixed.

Each time the frame 14 is raised for the purpose of moving it back and cause it to carry out a fresh glass shaping operation compressed air is admitted at 56. The piston is driven back, driving the rod 53 and pulling the chain 48, thereby causing the end roller 16 to turn a predetermined angle. Through the chain 45, and the wheel 44, this roller drives all the other rollers, which turn the same angle. The zone of the rollers which in the next phase comes into contact with the glass is thus not the same. A different part of the rollers is heated by contact with the glass, while the part previously heated is cooled.

In this arrangement the rollers 16 are able to turn freely on themselves at the moment when they make contact with the glass, this turning taking the form of rolling without friction until the rollers have reached the bottom of the concave parts of the corrugated glass.

There were 3 claims and the following references were cited in this patent: 1,450,222, Pattison, Apr. 3, 1923; 1,483,452, Keyes, Feb. 12, 1924; 2,590,768, Guilleminot et al., Mar. 25, 1952; and 2,655,196, Magnani, Oct. 13, 1953.

*Electroconductive Article. Fig. 2. Patent No. 2,741,570.* Filed March 5, 1953. Issued April 10, 1956. Assigned to Libbey-Owens-Ford Glass Co., by Romey A. Gaiser.

The present invention relates broadly to transparent, electrically conducting films, and more particularly to a glass sheet or plate provided with electrically conducting films of different characteristics on opposite surfaces thereof, and to a method of producing such a plate.

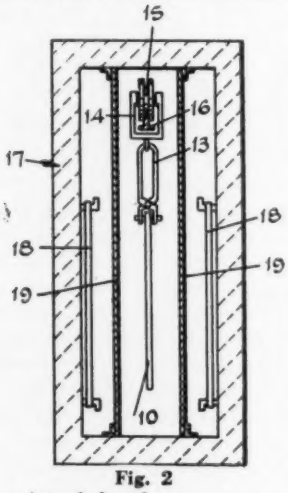

**Fig. 2**

In order to produce such films, the glass sheet 10 after being thoroughly cleaned may be suspended as shown in Fig. 2 from tongs 13 hung from a carriage 14 which is provided with wheels 15 running on a monorail 16. The carriage 14 is then moved along the rail 16 to carry it into a furnace 17, within which it can be heated to the temperature necessary for filming.

Within the furnace, the sheet 10 is heated to substantially the softening point of the glass.

Various tin compounds, including the tin halides, dissolved in suitable solvents can be used as the spray solution to produce the electrically conducting films and generally speaking, it is preferred to use stannic tetrachloride in an organic solvent such as isopropyl alcohol for the purpose. In order to obtain a uniform coating of the spray solution over the surfaces of the sheet 10, it is desirable to reciprocate the sprays back and forth over the sheet.

Ideally, in connection with aircraft glazings, it is desired to film the inboard glass surface of the outboard glass pane to a low resistivity in order that sufficient current may be passed through the film at an available voltage to produce heat for deicing purposes. However, a film that has a resistivity in the order of 100 ohms (10 to 1000 ohms per square) is too good a conductor to allow the passage of radio frequency energy.

The areas coated for static dissipation alone, will be coated on the outboard surfaces. However, the areas coated for deicing and electrostatic dissipation will be coated on both the inboard and outboard surfaces of the outboard pane.

The second method of obtaining high resistivities involves the use of spray solutions containing .5 per cent to 2 per cent of tin chloride in isopropyl alcohol.

It has also been found that the addition of gallium compounds to the spray solution act as resistivity stabilizers, and that thin films produced from spray solutions containing gallium will maintain their original resistivity within 25 per cent.

There were 3 claims and the following references were cited in this patent: 2,118,795, Littleton, May 24, 1938; 2,429,420, McMaster, Oct. 21, 1947; and 2,564,706, Mochel, Aug. 21, 1951.

## Tube and Cane Machines

*Glass Syringe Barrel Forming Method and Machine. Patent No. 2,771,710.* Filed February 18, 1953. Issued November 27, 1956. Four sheets of drawings; none reproduced. Assigned to Becton, Dickinson and Company by Henry G. Molinari and Julius V. Magash.

This invention relates to a structurally and functionally improved forming machine primarily intended for the production of hypodermic syringe barrels of glass. The forming machine consists of, in combination, a mandrel to receive a tube body and a support to limit the telescopic disposition of a tube over the mandrel. Means are also provided for exposing the mandrel to heat and a vacuum control acts to shift the supported tube. Provision is also made to permit the mandrel to extend into the open end of the barrel in order to properly shape the barrel and close the bore tip. The apparatus is relatively simple in design and yet rugged enough to be operated over long periods of time by relatively unskilled labor.

There were 24 claims and the following references cited in this patent: 680,306, Wilson, Aug. 13, 1901; 1,999,525, Morshoiz, Apr. 30, 1935; 2,209,739, Meyer, July 30, 1940; 2,490,252, Brewer, Dec. 6, 1949; 2,531,394, Campbell, Nov. 28, 1950; and 497,486, Great Britain, Dec. 19, 1938.

## Miscellaneous Processes

*Light-Diffusing Layer to Glass Surface. Fig. 5, Patent No. 2,727,830.* Filed July 8, 1954. Issued December 20, 1955. One sheet drawings. Assigned Hartford National Bank and Trust Co., by G. H. Janssen and P. C. van der Linden.

The invention relates to a method of applying light-diffusing layers to the inner wall of the bulb of an electric incandescent lamp, in order to prevent the filament body from shining through the bulb in a troublesome manner.

(*Continued on page* 703)

## Correlating Glass Furnace Operation and Basic Refractories

• THE ACCOMPLISHMENTS WITH basic refractories in glass furnace regenerators in recent years as compared with all other types of refractories has been truly outstanding. These accomplishments are not, however, limited to any one kind of basic refractory. Outstanding performances have been recorded for practically every class of basic refractory produced, and conversely nearly every type has proved inadequate under certain service conditions. It is, therefore, extremely important that both consumer and supplier of basic refractories for glass furnace regenerators be thoroughly familiar with the conditions that prevail, and with the effect of these conditions on the various basic refractories. The paper by J. J. Webber, in the July 1957 issue of the *Bulletin of the American Ceramic Society*, deals primarily with the more usual operating conditions that occur in glass furnace regenerators and the effect of these conditions on the various basic refractories.

Operating conditions can be divided into two main categories, namely (1) those related to firing and (2) those related to other factors, such as kind of glass being melted, and amount of volatile and fine batch material carried over into the regenerators.

It is not possible to measure precisely the degree of oxidation or reduction of the waste gases passing over a basic checker setting at every moment of every reversing cycle. Cyclic changes from oxidizing to reducing conditions and vice versa, can be damaging to basic refractories in the temperature range of glass furnace regenerators. Because of the importance of this cyclic effect, a laboratory procedure has been developed to evaluate the effect of simulated cyclic oxidizing and reducing atmospheres on the various classes of basic refractories. This test consists of repeated exposure of representative samples of the refractories at 2200° F. to an atmosphere of air for 15 minutes, followed by an atmosphere of 12 per cent carbon monoxide and 88 per cent nitrogen for the same length of time. Exploratory tests indicated that this temperature was in the most effective range. The mixture of 12 per cent carbon monoxide and 88 per cent nitrogen is representative of the gas that could exist in a glass furnace checker setting. The condition of the refractory samples after exposure to a given number of cycles gives a comparative measure of their stability under these conditions. A cycle is one exposure of air and one exposure to the carbon monoxide and nitrogen mixture.

Stabilized forsterite brick differs from that of the conventional class primarily in the fact that it contains a stabilizing mineral which gives it resistance to cyclic oxidizing and reducing atmospheric conditions. Forsterite refractory without the stabilizing mineral has about the same resistance to these cyclic conditions as most of the other basic refractories. Only the stabilized forsterite and high magnesia-low iron basic refractories, however, adequately resist these cyclic conditions. Refractories of the forsterite type, stabilized or not, have a further advantage of being more resistant to most other conditions that prevail in glass furnace regenerators than are refractories of the high magnesia classes.

There is a wide variation in the severity of the conditions that exist in various glass-making operations. Differences in batch composition may have a considerable influence on the basic refractories in the regenerators. Even batch materials that are identical chemically but different physically may affect the basic regenerator refractories very differently. All of these variables related to batch may be summed up in the general classification of "batch carry-over reactions."

Any discussion of batch carry-over reactions should take into consideration at least the general types of glass, such as soda-lime, borosilicate, lead, and others. Although basic refractories are being used to some extent in furnaces used for melting all types of glass, by far the majority of the experience with such refractories in glassmaking has been with soda-lime glasses. The adaptation of basic refractories to boro-silicate glass furnaces has been particularly difficult. Considerable progress has been made, however, in this connection with intermediate soda-borosilicate compositions and the outlook for high boron compositions now seems good. For the sake of brevity, however, this paper was limited to soda-lime glass.

The effect of variations in composition and quantity of batch carry-over materials is further complicated by a considerable range of maximum temperatures which prevail in the regenerator chambers of furnaces of the different designs, or even in furnaces of identical design that are operated differently. Much valuable information is obtained from service data through comparisons of the service given by various classes of basic refractories in a given operation. Comparisons of results secured in different furnaces where it is possible to define the conditions accurately, also provides information of value. Controlled laboratory investigations are most helpful in obtaining a fundamental understanding of these refractories. Microscopic examination of refractories which have been in service also furnish valuable information.

The excellent resistance of stabilized forsterite to reaction with silica and alkali carry-over is illustrated by the service given in the regenerator of a silicate of soda furnace after 44 weeks of operation. The service was particularly severe because large charges of batch were introduced periodically through the crown. The large amount of batch dust that results from this method of charging will cause severe damage to a fireclay refractory setting in this length of time. None of the brick failed even at the top of the setting that takes the full brunt of the batch carry-over. The operators expect this setting to last for many more months. Other stabilized forsterite settings in silicate of soda furnaces that have continuous batch charging have been in relatively good condition after more than two years which is approximately double the service obtained with fireclay refractories.

Burned forsterite refractories are strong throughout

the entire temperature range to which glass regenerator checkers are exposed. Chemically bonded basic refractories, however, lose strength with increased temperature because of changes in the chemical bond. The strength is lowest between 1500° and 1700°F. and then gradually increases, but never equals that of hard-burned basic brick which have had a ceramic bond developed at higher temperatures. The use of chemically bonded basic refractories is therefore limited to types of settings that provide support for the checker brick throughout most of the brick length. Burned brick, however, because of their more uniform strength at all checker chamber temperatures, can safely span considerably wider openings. Settings that provide more support, such as the open basketweave arrangements, are preferable even for burned basic refractories for the longest service under extremely severe conditions.

In regenerators and crowns, refractories containing a considerable proportion of free magnesia tend to react with silica and lime in the batch carry-over, to form forsterite and monticellite, if temperatures are extremely high and the amount of carry-over is considerable. In wall applications, the expansion accompanying this reaction may cause shelling of the hot face of the refractory. Under these conditions, burned chrome-magnesite brick, which are very low in free magnesia, give best service in some cases.

In a few cases, as when there is a large amount of drip on the checker setting from fireclay regenerator upperstructures, burned chrome-magnesite refractories also give better life in top checker settings. For the most part, however, forsterite is the superior checker refractory for soda-lime applications.

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## J. T. LITTLETON TO RECEIVE TOLEDO AWARD

The 1958 Toledo Glass and Ceramic Award will be presented to Dr. Jesse T. Littleton, retired vice president of research, Corning Glass Works, on Monday, January 20 at an Award Dinner in Toledo, it has been announced.

The award will be presented in conjunction with a symposium, "Glass Melting", to be held earlier the same day. Other events have been planned. The program for the day of the award is as follows:

The Hospitality Headquarters, Apt. 311, Hillcrest Hotel, 16th and Madison in Toledo will be open from 9 A.M. for registration. There will be a program of interest to the ladies, in charge of Mrs. Fred Bishop and Mrs. Ralph K. Day. Hospitality Headquarters will remain open until midnight.

At 12 noon there will be a luncheon at the Hillcrest Hotel, Parlors C, D, and E, third floor.

At 1:30 the symposium, "Glass Melting", will begin. The specific question of discussion will be: what are the limiting conditions for preparation of glass which are adequate for a forming process. Professor Fay V. Tooley, University of Illinois will be moderator. Qualified men in the glass field will form a panel and present short talks after which open discussion is invited.

At 5:30 there will be a cocktail hour at the Toledo Club, 14th and Madison, north end lounge.

The Award Dinner and presentation of the Award Vase will be held at 7, at the Toledo Club, Great Lakes Room. Ralph B. Vogel, National Lime and Stone Company, Findlay, Ohio, who is chairman of the Northwestern Ohio Section of the American Ceramic Society will be toastmaster. Many of Dr. Littleton's friends and associates will be present to offer their good wishes.

After the dinner there will be open house at the Hospitality Headquarters, Apt. 311, Hillcrest Hotel.

Chairman, General Arrangements,: Delos M. Palmer, Delos M. Palmer and Associates, Toledo, Ohio. In charge of arrangements for Toledo University: Dr. A. Solberg. Dean of Research, Toledo University, Toledo, Ohio.

The General Arrangements Committee consists of: Ralph B. Vogel, National Lime and Stone Company; Ralph K. Day, Libbey Owens Ford Glass Company; William V. Frederick, Libbey Owens Ford Glass Company; A. H. Couch, Libbey Owens Ford Glass Company; Howard R. Swift, Libbey Owens Ford Glass Company; C. J. Brown, Libbey Owens Ford Glass Company; Milton Adams, Libbey Owens Ford Glass Company; J. G. Mohr, Barrett Division, Allied Chemical & Dye Corp.; Fred L. Bishop, Owens Illinois Glass Company; Frank Bacon, Owens Illinois Glass Company; and Arthur VanZee, Owens Illinois Glass Company.

Reservations for the hotel and the Award Dinner should be forwarded to Delos M. Palmer, Delos M. Palmer and Associates, 4401 Jackman Road, Toledo, Ohio.

## NEW GLASS PLANT TO BE IN JAMAICA, B. W. I.

A $2,500,000 glass manufacturing plant and extensive silica and quartz mining facilities will be established in Jamaica, B. W. I., as a result of agreements just completed between the principals and the Jamaica Industrial Development Corporation, it was announced recently by Carroll C. da Costa, the Corporation's international representative.

Making the announcement on the eve of the first anniversary of the Industrial Development Corporation's offices in New York, Mr. da Costa said the new industry was the largest of numerous U. S. firms which have opened manufacturing facilities in Jamaica since the country's government passed incentive legislation giving foreign industry generous tax and duty concessions.

The new glass manufacturing industry, which will utilize silica and quartz deposits recently discovered to be in commercial quantity in Jamaica, will be operated by Jamaica Glass Products Limited, a new company formed by Philip B. Bateson of New York City, and Walter L. Maguire of Stamford, Conn.

Mr. da Costa said that the principals have also formed Jamaica Ores Limited, which will mine and treat the silica and quartz sand from which the glass will be made. The two companies are scheduled to begin production in 16 to 18 months and will be among the largest employers on the island. Mr. Bateson and Mr. Maguire have been associated previously in oil and gas industries in the southwest U. S., Mr. da Costa said.

• Henry F. Teichmann, Inc. has moved as of November 22 from downtown Pittsburgh to modern new offices on Route 19 South in Peters Township, Washington County. In addition to the office building, adequate ground has been secured to allow for the expansion of the firm into research and light manufacturing.

# Current Statistical Position of Glass

**Employment and payrolls:** Employment in the glass industry during September, 1957 was as follows: *Flat Glass*: A preliminary figure of 27,800 for September 1957 indicates an increase of 1.1 per cent from the adjusted 27,500 reported for August, 1957. *Glass and Glassware, Pressed and Blown*: An increase of .1 per cent is shown by the preliminary figure of 83,900 for September, 1957, when compared with the adjusted figure of 83,800 for August, 1957. *Glass Products Made of Purchased Glass*: The preliminary figure of 13,800 for September, 1957 indicates a decrease of .7 per cent from the previous month's adjusted figure of 13,900.

Payrolls in the glass industry during September, 1957 were as follows: *Flat Glass*: An increase of 2.2 per cent is shown in the preliminary $13,375,589.70 when compared with August, 1957's adjusted $13,090,550.65. *Glass and Glassware, Pressed and Blown*: A decrease of .2 per cent is shown in the preliminary $30,442,730.74 reported for September, 1957 when compared with the previous month's adjusted $30,500,853.60. *Glass Products Made of Purchased Glass*: A preliminary figure of $4,345,331.72 was reported for September, 1957. This is an increase of 3.4 per cent when compared with the adjusted figure of $4,202,758.69 for the previous month.

**Glass container production:** Production based on figures released by the Bureau of Census was 13,089,000 gross during October, 1957. This represents an increase of 7.3 per cent from the previous month's production of 12,201,000 gross. During October, 1956, glass container production was 13,377,000 gross or 2.2 per cent over the October, 1957 figure. At the end of the first ten months of 1957 glass container manufacturers have produced a preliminary total of 124,223,000 gross. This is 4 per cent over the 119,413,000 gross produced during the corresponding period in 1956.

Shipments of glass containers during October, 1957 were 12,818,000 gross, or an increase of 37 per cent from September, 1957 shipments which were 9,356,000 gross. Shipments during October, 1956 were 15,010,000 gross or 14.6 per cent over October, 1957. At the end of the first ten months of 1957 shipments have reached a total of 120,692,000 gross, which is .015 per cent over the 120,517,000 gross shipped during the corresponding period last year.

Stocks on hand at the end of October, 1957 were 16,943,000 gross. This is 1.6 per cent higher than the 16,668,000 gross on hand at the end of September, 1957 and 44 per cent above the 11,721,000 gross on hand at the end of October, 1956.

**Automatic tumbler production:** During September, 1957 this production was 4,481,000 dozen; this is a gain of 676.6 per cent against the September, 1956 production which was 577,000 dozen.

Shipments during September, 1957 rose to 4,029,000 dozen. This is 368.5 per cent higher than the 860,000 dozen shipped during September, 1956. At the end of the twelve months' period ending September 30, 1957, shipments have reached a total of 57,850,000 dozen which is 2.4 per cent higher than the 56,486,000 dozen shipped in the previous period.

**Table, kitchen and household glassware:** Manufacturers' sales of machine-made table, kitchen and household glassware during September, 1957 reached 2,558,000 dozen. This is 250.9 per cent over the 729,000 dozen of September, 1956. At the end of the twelve months period ending September 30, 1957, manufacturers had sold a total of 37,342,000 dozen, which was 13.7 per cent higher than the 32,843,000 dozen sold during the previous corresponding period.

## GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

| | Oct., 1957 |
|---|---|
| **Narrow Neck Containers** | |
| Food | 1,398,000 |
| Medicinal and Health Supplies | 1,938,000 |
| Chemical, Household and Industrial | 849,000 |
| Toiletries and Cosmetics | 876,000 |
| Beverage, Returnable | 294,000 |
| Beverage, Non-Returnable | 77,000 |
| Beer, Returnable | 84,000 |
| Beer, Non-Returnable | 689,000 |
| Liquor | 1,066,000 |
| Wine | 480,000 |
| Sub-total (Narrow) | 7,751,000 |
| **Wide Mouth Containers** | |
| Food | *3,538,000 |
| Medicinal and Health Supplies | 462,000 |
| Chemical, Household and Industrial | 207,000 |
| Toiletries and Cosmetics | 237,000 |
| Packers' Tumblers | 66,000 |
| Dairy Products | 206,000 |
| Sub-total (Wide) | *4,716,000 |
| Total Domestic | 12,467,000 |
| Export Shipments | 351,000 |
| TOTAL SHIPMENTS | *12,818,000 |

*This figure includes Fruit Jars and Jelly Glasses.

## GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

| | | Production Oct., 1957 | Stocks Oct., 1957 |
|---|---|---|---|
| Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics | Narrow Neck | 4,991,000 | 6,076,000 |
| | Wide Mouth | *4,765,000 | *5,405,000 |
| Beverage, Returnable | | 477,000 | 1,790,000 |
| Beverage, Non-Returnable | | 67,000 | 223,000 |
| Beer, Returnable | | 97,000 | 371,000 |
| Beer, Non-Returnable | | 693,000 | 679,000 |
| Liquor | | 1,210,000 | 1,438,000 |
| Wine | | 477,000 | 550,000 |
| Packers' Tumblers | | 81,000 | 127,000 |
| Dairy Products | | 231,000 | 284,000 |
| TOTAL | | *13,089,000 | *16,943,000 |

*This figure includes Fruit Jars and Jelly Glasses.

## U. S. BORAX DEDICATES FIRST OPEN PIT BORAX MINE

On November 13, the United States Borax and Chemical Corporation dedicated its new open pit mine and refinery at Boron, California, in the Mojave desert, one hundred and thirty miles northeast of Los Angeles.

This new open pit borax mine, the first of its kind, with its associated concentration and refining plants, represents a twenty million dollar investment and took two years to complete. Covering approximately eighty acres, the new facilities are located at the site of the largest deposit of sodium borate known in the free world.

**The open pit mine and refinery.**

The designing, engineering and construction work was a joint venture of Sweco-Twaits, the Southwestern Engineering Company and Twaits- Wittenburg Company. During the peak of construction five hundred engineering and construction personnel were on the job. An estimated million man hours went into the project.

About thirty thousand cubic yards of concrete were used for construction of the various facilities. A special cement plant was constructed on the project site and the aggregate was trucked to Boron from Little Rock, California, a distance of fifty miles.

Of particular interest are the four massive thickener tanks, said to be the largest covered and insulated tanks of their type in the world. These tanks, which act as settling vessels and produce clear borax solution, are each 230 feet in diameter and eight feet high with individual capacity of more than 3,000,000 gallons. Each tank, with an area of 40,000 square feet, is built up with ¼ inch steel plate in the bottom and ⅜ inch plate on the sides and roof. Approximately 1800 tons of steel plate and more than 800 tons of structural steel framing were used in their construction.

The tanks are designed to allow for heat expansion differential, allowing for an internal 210° F. liquid temperature and an external ambient temperature which varies from 30° F. to 110° F.

Another design feature of each tank is the concrete column in the center which supports the roof and allows a 50 ft. clear span. The column also carries the drive mechanism for the thickener.

The four crystallizers which supersaturate the borax solution after it leaves the thickeners weigh 308 tons. The crystallizers rise to a height of 75 ft.

The 12 storage silos, each 100 ft. in height, were built of reinforced concrete and have the following capacities: six silos for 5 mol crude have a capacity of 13,400 tons; three silos for 5 mol refined have a capacity of 6300 tons; three silos for AB anhydrous borax have a capacity of 6900 tons.

Some 9,000,000 tons of earth were removed in digging the pit to the ore deposit at a depth of 137 feet. The pit is now 175 feet deep. This marks the first time borax has ever been mined by the open pit method, which allows a virtual 100 per cent recovery of ore.

At a press conference preceding the dedication ceremonies, James M. Gerstly, president of the corporation, said that at the present rate of mining—800,000 tons a year—the company can help meet the needs of the free world for industrial and defense purposes for one hundred years.

California, Mr. Gerstly stated, produces ninety-five percent of the free world's borate with seventy per cent of this total coming from the corporation's eighty acre facility.

During the dedication ceremonies the romance of the desert was not overlooked. As a prelude to the program there was a narration about the early days of borax mining and the 20 mule team.

Following Mr. Gerstly's opening address, J. F. Corkiel, vice president and general manager of the company's

**In the background is the company's old plant which eventually will be closed down. The new facilities will produce more than 70 per cent of the free world's supply of boron. Near the center of the picture are the four thickener tanks used as settling vessels.**

Pacific Coast Borax Division, took over as master of ceremonies.

Participating in the dedication ceremonies were Under-Secretary of the Interior Hatfield Chilson; California's Lt. Governor Harold J. Powers; Brig. General Marcus F. Cooper, U. S. A. F., Commander, Air Force Flight Test Center, Edwards Air Force Base; and W. C. Fortune, U. S. A. Bureau of Aeronautics.

Following the ceremonies at the pit, some three hundred special guests enjoyed cocktails and luncheon on the camp site.

# New Equipment and Supplies

## NON-SLIP COATING GETS GOOD HEALTH REPORT

Paisley Products Incorporated, Division of Morningstar, Nicol, Inc., 630 West 51st Street, New York 19, N.Y., has announced that their non-slip coating No. 1715, being sprayed on corrugated shipping containers and blanks, has been given a clean bill of health by Leon D. Horowitz, PE, New York, industrial hygiene consultant and authority on air pollution, safety and dust problems.

Paisley and Container Corporation of America, Philadelphia Container Division cooperated to engage the consultant, who affirmed that the product was safe in relation to both air pollution and toxicity.

He was assigned to conduct thorough tests at the discharge end of the printer-slotter at CCA where the product is sprayed from four guns at a distance of 16 inches onto corrugated container blanks in high speed production.

Samples were drawn from the area directly under the hood adjacent to the spray guns, as well as from points at the discharge end of the machine where the loaders work. Dust concentrations were measured by the Greenburg-Smith Midget Impinger method, using isopropyl alcohol to disperse the particles for microscopic inspection under strong light beams. Even with the exhaust system turned off dust concentrations at the worst locations did not exceed 17 million particles per cubic foot (mppcf).

## ELECTRON MICROSCOPE

Philips Electronics, Inc., Instruments Division, 750 South Fulton Avenue, Mount Vernon, N. Y., has available a new Norelco electron microscope for analytical work in industrial processing, research, etc. The microscope has an objective lens which has an externally adjustable mechanical compensator with a single control, indexed and coupled to double dipoles positioned on the face of the pole shoe. Transmission electron diffraction patterns are obtained through a simple lens current adjustment.

The new instrument permits stereo images to be produced by rotating the specimen rod under vacuum. Magnification is continuously variable and can be varied from 1200-12,000 diameters on the screen. Resolving power is better than 50 Angstroms. High voltage supply is continuously variable from 20 to 75 Kv. Screen image is 90 by 90 millimeters at all magnifications. An image viewing magnifier (2X) mounted on a swivel or a binocular attachment (8X) with metal viewing chamber and camera are interchangeable accessories.

Film cassette accommodates up to 36 indexed exposures on film without changing camera, or 8 plates with metal viewing chamber and camera. Micrographs are 28 by 28 mm standard fine grain film or 3¼ by 4 inch glass plates. Useful photographic enlargements may be made up to 50,000X using 35 mm film or 100,000X using glass plates. The objective aperture is easily demountable for cleaning and has a 3-dimensional adjustment.

Since the vacuum pump is air cooled, cooling water is unnecessary. Pump-down time required before the new EM-75-B unit can be operated from a cold start is 20 minutes; after changing filament or camera—15 minutes; after changing specimen—20 seconds.

The new instrument has a console cabinet with the column supported at the center of the working area. Controls are on sloping panels, facing the operator.

## MIDDLE SIZED AIR COMPRESSOR

Atlas Copco Eastern, Incorporated, 151 Linwood Avenue, Paterson, N. J., has announced it has added a new intermediate size air compressor, the AR-3, to its series. The new model has a free air delivery ranging from 570 to 680 cubic feet per minute at 100 psi and is available for permanent installation or as a skid-mounted unit. The power input is claimed to be up to 10 per cent less than that of other machines for the same amounts of free air, and the space requirement as much as 25 per cent less. Further economies stem from the AR series special heat recovery systems which can convert up to 60 per cent of the total power input into hot water. Annular type valves provide larger air flow-through areas than standard valves. Weighing 5,400 pounds, the AR-3 draws 600 gallons of cooling water per hour at 60 degrees Fahrenheit. The new compressor measures 60 inches deep, 41 inches wide and 72 inches high.

## LOW COST LAB FURNACE

Selas Corporation of America, Dresher, Pa., has manufactured a compact, low cost crucible furnace designed for the laboratory, suitable for small melts and for testing of small samples at temperatures up to 2650 F. (1455 C.)

Fired by any available fuel gas (natural, manufactured, mixed, or LP) and air under low pressure, the furnace is chambered for crucibles up to 15/16 of an inch base dia. by 2¼ inches high. It sells for less than $100 including a gas-air mixing device.

The design of the crucible furnace is based on a similar production furnace field-tested over a number of years in such uses as melting dental metals and dip-welding wires.

## CATALOGS RECEIVED

*Link-Belt Company*, Dept. PR, Prudential Plaza, Chicago 1, Ill., has available an 88 page book on silent chain drives, which gives detailed engineering data and illustrations of the chain's versatility in a wide range of applications.

Book 2425 contains tables of service factors, ratings, chain length and center distance computations. Pre-engineered stock drives are listed in one 16-page section. A 22-page section outlines the procedure for selection of engineered drives. Another section on drive components lists available chain widths; chain and wheel dimensions; wheel tolerances, materials and other data.

Book 2425 will be sent without charge on request to Link-Belt Company.

*Leeds & Northrup Company*, 4934 Stenton Avenue, Philadelphia 44, Pa., has prepared a two page preliminary data sheet on a new thermocouple Electromax signalling controller for two-position control. The instrument provides low cost electronic control for many processes where a record or continuous indication is not required. Small and compact, it is ideal for use on many electric and fuel-fired furnaces, ovens, some types of chemical processing units, and plastic extruding machines. Other uses include zone control on continuous ovens and kilns, and excess (overheat) temperature cut-out control. Specifications and ordering instructions are included in this data sheet. Ask the company for Preliminary Data Sheet ND47-33(1).

*The Chas. Taylor Sons Company*, P.O. Box 58, Annex Station, Cincinnati 14, Ohio, has published a bulletin titled "A Guide to the Selection of Taylor-Made Special Refractories". The illustrated, 24-page, pocket-sized booklet gives detailed information on castables, cements, ramming mixes, and patches. Request bulletin No. 324 direct from the company.

*The Bristol Company*, Waterbury 20, Conn., will send on request their 4-page, 2-color bulletin describing and illustrating the company's new line of small size, self-balancing electronic potentiometers and bridges. The new instruments match the appearance of the company's pneumatic Metagraphic instruments for graphic panel and console use. They are made in both recording and indicating versions, and the two types of chassis are interchangeable through plug-in construction features. The recorder uses a 3-inch strip chart. Face dimensions are only 5 by 5⅛ inches. Ask for bulletin P1271.

## COLUMBIA-SOUTHERN HIRES GLASS TECHNICIANS, INC.

Glass Technicians, Inc. of Hamilton, Ohio, has been retained by Columbia-Southern Chemical Corporation to supply technical service to Columbia's customers in the glass industry.

Known for their technical services to the glass container industry, Glass Technicians, Inc. has served as consultants on varied problems throughout the industry.

According to C. F. Bingham, vice president-sales, Columbia-Southern Chemical Corporation, the consulting service will be available upon request to Columbia-Southern. It will be integrated with the chemical manufacturer's own technical service department.

R. W. Hopkins, president, and W. H. Manring, vice president and chief engineer of Glass Technicians, Inc., will be Columbia-Southern representatives for this technical service.

R. W. Hopkins

W. H. Manring

Mr. Hopkins graduated from Ohio State University in 1931 with a degree of Bachelor of Ceramic Engineering. He joined Owens-Illinois at Toledo, Ohio, later served the company at Charleston, W. Va.; Fairmont, W. Va.; Streator, Illinois; Alton, Illinois; and Bridgeton, N. J.

Ohio State University conferred the degree of Professional Ceramic Engineer on him in 1941 and in 1944 he organized The Calumite Co., in Hamilton, Ohio, and still serves as president of that firm.

Mr. Hopkins began Glass Technicians, Inc., in 1955, also serving as president of this organization which deals principally in consulting work for the glass industry. He is a director of The Calumite Company of California and several other companies involved in ceramic and metallurgical manufacture.

Mr. Manring received his B.S. degree in 1937 from Ball State College in Muncie, Indiana. From 1937 to 1940 he served as an assistant in instruction in the chemistry department of this institution while continuing work on a Master's degree.

In 1940 he entered the employ of Ball Brothers Company, Inc., Muncie, Indiana, as a junior chemist, serving progressively as senior chemist and chief glass technologist, holding this position until 1951.

In 1951, Mr. Manring entered the employ of The Calumite Company, Hamilton, Ohio, as chief engineer and as a consultant on glass problems. He is also a member of the staff of Glass Technicians, Inc., and became vice president of that organization in 1957. He has been a member of the American Ceramic Society since 1944.

## SOCIETY OF RHEOLOGY HOLDS ANNUAL MEETING

The Society of Rheology held its 1957 Annual Meeting in Princeton, New Jersey, on November 7-9. The technical sessions and business meeting were held at Textile Research Institute. The meeting was marked by having the largest attendance in the history of the Society: 122 members and 43 guests.

At the Social Hour Smoker on the evening of November 7th, Dr. Clarence M. Zener, Director of the Research Laboratories of the Westinghouse Electric Corporation, was presented the Bingham Medal of the Society. The presentation of the medal was made by Dr. Arthur S. Nowick, of the IBM Watson Laboratory, Columbia University. Dr. Nowick discussed the medalist's scientific accomplishments in several areas.

The meeting's technical program was divided into six half-day sessions, beginning on Thursday morning, November 7, and ending on Saturday afternoon, November 9. At the first session, two of the papers were devoted to the theory of peeling an adhesive material placed between a rigid plate and a flexible ribbon. During the Thursday afternoon session, several papers were presented in which measurements of the dynamic mechanical properties of various polymers were reported.

The Friday morning session was devoted chiefly to papers describing the flow properties of various polymer systems and the techniques used to measure these properties. During the afternoon session, papers were presented on a variety of topics, which included the cooling time of glass fibers, the relaxation spectra of high polymers, stress relaxation in glass, and the rheology of a liquid emerging from a capillary.

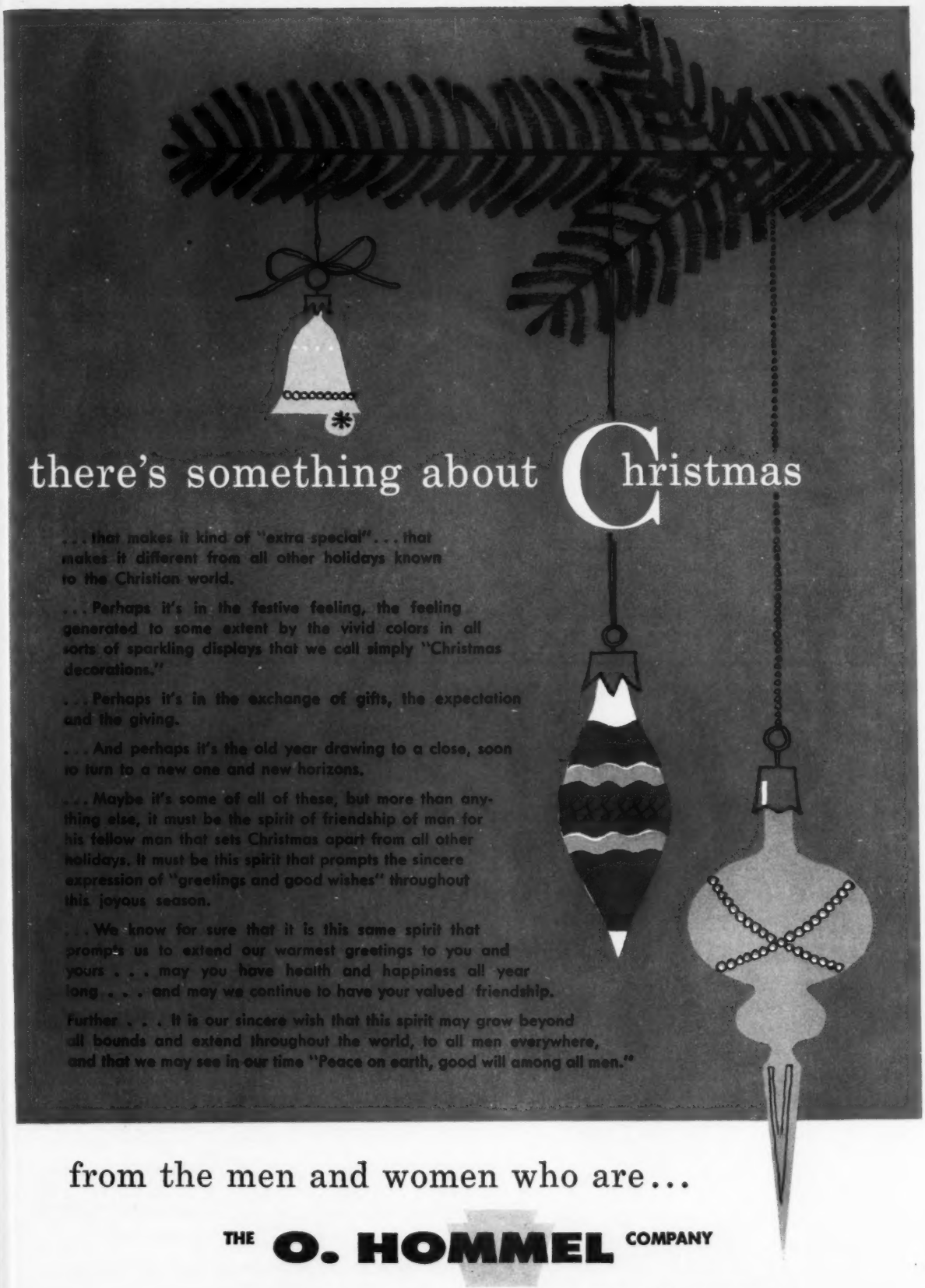
The subjects considered in the papers given during both the morning and afternoon sessions on Saturday were also characterized by their variety.

At the business meeting, held Friday afternoon, November 8, after the technical session, plans were announced by F. D. Dexter to hold the 1958 Annual Meeting on November 5-7 at the Franklin Institute, in Philadelphia, Pennsylvania. The results of the Society's election of new officers were also announced at the meeting. J. H. Dillon, Textile Research Institute, was elected president, succeeding F. D. Dexter, Bakelite Company. J. H. Elliott, Hercules Powder Company, was elected vice president; W. R. Willets, Titanium Pigment Corporation, was elected secretary-treasurer; and R. D. Andrews, Dow Chemical Company, was elected editor. R. S. Marvin, National Bureau of Standards, and R. S. Rivlin, Brown University, were elected members of the executive committee, which also includes the officers.

## G. A. MENGLE NAMED G.C.M.I. COMMITTEE CHAIRMAN

Glenn A. Mengle, president of Brockway Glass Company, Inc., headquarters of which are in Brockway, Pennsylvania, has been named to the chairmanship of the market research and promotion committee of the Glass Container Manufacturers Institute.

Mr. Mengle succeeds Franklin A. Pollock, chairman of the board of Thatcher Glass Manufacturing Company, Inc., of Elmira, New York, who resigned from the post after four years of service.


there's something about Christmas
. . . that makes it kind of "extra special" . . . that makes it different from all other holidays known to the Christian world.
. . . Perhaps it's in the festive feeling, the feeling generated to some extent by the vivid colors in all sorts of sparkling displays that we call simply "Christmas decorations."
. . . Perhaps it's in the exchange of gifts, the expectation and the giving.
. . . And perhaps it's the old year drawing to a close, soon to turn to a new one and new horizons.
. . . Maybe it's some of all of these, but more than anything else, it must be the spirit of friendship of man for his fellow man that sets Christmas apart from all other holidays. It must be this spirit that prompts the sincere expression of "greetings and good wishes" throughout this joyous season.
. . . We know for sure that it is this same spirit that prompts us to extend our warmest greetings to you and yours . . . may you have health and happiness all year long . . . and may we continue to have your valued friendship.
Further . . . It is our sincere wish that this spirit may grow beyond all bounds and extend throughout the world, to all men everywhere, and that we may see in our time "Peace on earth, good will among all men."

from the men and women who are...

THE **O. HOMMEL** COMPANY

PITTSBURGH, PA. LOS ANGELES, CALIF.

### OWENS-CORNING RESEARCH EXPANSION IS ANNOUNCED

Expansion of Owens-Corning Fiberglas Corporation's research and product and process development activities has been announced by Harold Boeschenstein, president of the company.

A major move in the expansion plans includes the establishing of a Pioneering Laboratory reporting directly to Games Slayter, Newark, research and development vice president of Owens-Corning. The Pioneering Laboratory will be located west of Granville near Denison University on route 16.

The Pioneering Laboratory will operate independently of the company's Basic and Applied Research Laboratory located at the Newark Plant site and the Divisional Product and Process Development Laboratories located in Newark, Ashton, Rhode Island, and Santa Clara, California.

The Pioneering Laboratory is being established under Mr. Slayter's direction to work on certain longe-range development projects which have significant potentials in fields related to Fiberglas. In addition to his responsibilities as director of the Pioneering Laboratory, Mr. Slayter will continue as chairman of the research, development and engineering subcommittee of the company.

Preliminary steps for the construction of the new Pioneering Laboratory facility have been started under direction of Owens-Corning's general engineering staff.

Dr. A. C. Siefert will continue as director of the Fiberglas Basic and Applied Research Laboratory and will report to the president of the company.

L. P. Biefeld

A. C. Siefert

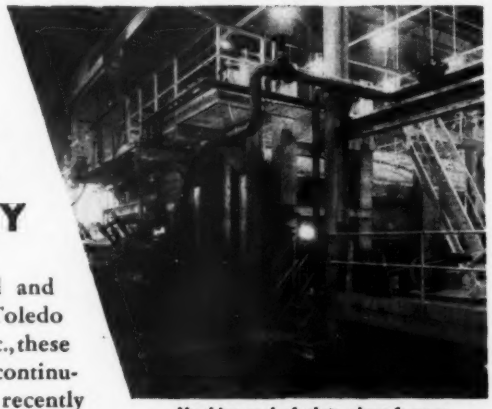
Dr. L. P. Biefeld, formerly technical director on the research and development staff, Newark, has been appointed to the newly-created post of technical assistant to the president with headquarters in Toledo.

### VON BERGEN TO FM INTERNATIONAL

Fritz von Bergen has been appointed assistant manager, Chemical Operations Department, of FMC International, a newly formed division of Food Machinery and Chemical Corporation. Mr. von Bergen's responsibilities will center around exploration and development of chemical opportunities in the international field, it was stated by W. D. Morrison, manager of the Chemical Operations Department.


GLASS MELTING FURNACES

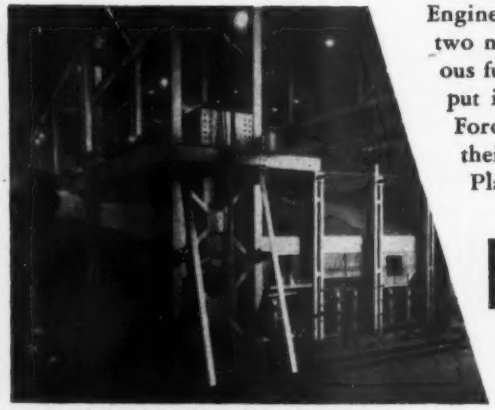
by TECO for FORD MOTOR COMPANY



Machine end of plate glass furnace.

Completely designed and constructed by The Toledo Engineering Co., Inc., these two new modern continuous furnaces were recently put into operation by the Ford Motor Company at their Nashville, Tenn. Glass Plant.

We solicit inquiries for any phase of glass plant engineering or construction.



Adjustable curtain—sheet glass furnace.

TOLEDO ENGINEERING Company

PHONE-GREENWOOD 5-1529

DESIGNERS AND BUILDERS OF GLASS MELTING FURNACES

3001 SYLVANIA AVENUE, TOLEDO 13, OHIO

**Inventions . . .**
(*Continued from page 694*)

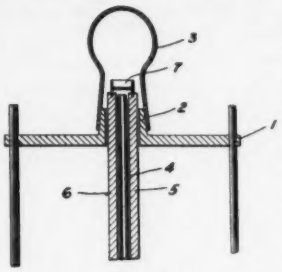


**Fig. 3**

A satisfactorily adhesive light-diffusing magnesium oxide layer is obtained by exposing the glass surface to gaseous oxidation products of phosphorous during or prior to the deposition of magnesium oxide. The treatment with the gaseous oxidation products is preferably carried out simultaneously with the application of the magnesium oxide by burning of the metal since the temperatures when prevailing are sufficient to ensure the desired reaction of the oxidation products with the glass surface.

Referring to Fig. 3, a stand plate 1 is provided with a projecting holder 2 which fits in a bulb 3 for an incandescent lamp. Through an aperture provided in the holder 2 a tube 4 for the supply of oxygen and/or air required for the combustion of magnesium and phosphorous is led in. This tube may, as an alternative, be used for the supply of gases capable of yielding oxidation products of phosphorous. A container 7 made of tungsten is mounted on two insulated current supplies 5 and 6. In this container, which may be heated by the passage of current, the magnesium and, as the case may be, the phosphorus may be ignited.

There were 5 claims and the following references cited in this patent: 2,171,227, Schreinemachers, Aug. 29, 1939; and 2,451,590, Tidak et al., Oct. 19, 1948.

*Manufacturing of Cathode-Ray Tube Envelopes. Fig. 4. Patent No. 2,713,754.* Filed July 23, 1953. Issued July 26, 1955. One sheet of drawings. Assigned to The Rauland Corporation by David Nixen and Russell B. Snyder.

This invention pertains to the manufacture of cathode-ray tube envelopes and more particularly to a new and improved method for sealing a glass face-plate to a metal cone section to form such an envelope. In accordance with the invention (See Fig. 4) a coating of a solution of ammonium dichromate is applied to the surfaces 13a and 13b of sealing land 13 before face-plate 12 is positioned on the sealing land and sealed. Preferably, the solution is also applied to the inner surface of cone 10 in the region immediately adjacent sealing land 13. The solvent for the ammonium dichromate must be volatilizable so that any residual solvent is vaporized and driven off during the heating of rim 14 and land 13 in the subsequent sealing steps of the process. Preferably, the solvent for the ammonium dichromate should be water or a mixture of water and some other liquid vehicle of a more volatile nature such as acetone; however, any other suitable solvent or liquid vehicle, such as alcohol, which does not precipitate the ammonium dichromate or form solid by-products during the heating cycle of the sealing process may be employed. It is pre-

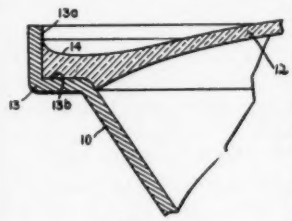


**Fig. 4**

A COMPLETE REFRACTORIES SERVICE . . .
***for the Glass Industry***

Brick are important to the glass industry which supplies all of us with a multitude of everyday necessities.

RITEX basic brick, for regenerator chambers and checkers, make a four year campaign more than a wistful dream. Unaffected by batch carry-over and condensed soda, RITEX magnesite checker brick retain their full size and original regenerator efficiency month after month. RITEX CHROME brick, for the regenerator crowns and walls, have low conductivity which can be translated into fuel savings. They can be insulated without seriously affecting their service life because they do not melt or slag at the operating temperatures encountered.

Grefco fire clay brick are recommended for the lower portions of the checker settings, the lower regenerator walls, the rider tile and for lining the flues.

Grefco silica brick, for caps and breast walls, are uniform and of highest quality, and are available in standard or super duty grade.

You will find one or more Grefco plants ready to supply each major glass producing district at minimum transportation costs.

GENERAL REFRACTORIES CO.
Philadelphia 2, Pa.

GENERAL REFRACTORIES

# Milestones in Glass Progress

PHOTO COURTESY OWENS-CORNING FIBERGLAS CORPORATION

*1933* Insulation made from fibrous glass, and faced on one side with aluminum foil, increases insulating efficiency. This design enables insulation to "breathe" toward the outside, while foil facing reflects heat and acts as a vapor barrier. Glass insulation will not rot, decay, or provide food for insects or rodents.

*1890* Michigan Alkali Company, now a division of Wyandotte Chemicals Corporation, was founded by Captain J. B. Ford to supply Soda Ash to the glass industry. Part of its modern Soda Ash facilities are huge, seven-story kilns (shown above), for roasting limestone. Wyandotte is a working partner, supplying technical assistance and raw-material chemicals to those great companies marking milestones in glass progress.

**Wyandotte CHEMICALS**

*Michigan Alkali Division, Wyandotte Chemicals Corporation*
*Wyandotte, Michigan • Offices in principal cities*

*Founded by a Glassmaker to Serve the Glass Industry*


ferred that the ammonium dichromate coating be permitted to dry prior to sealing the face plate to cone section 10; however, this step is not essential and the face plate may be positioned on and sealed to sealing land 13 immediately following application of the ammonium dichromate coating. This method thus inherently avoids any special baking or washing procedures prior to sealing. It is less cumbersome and less expensive.

The patent contains nine claims and the following references were cited: 2,296,307, Power, Sept. 22, 1942; 2,639,555, Buttino et al., May 26, 1953; 23,404, Great Britain, 1910; also Rose, Arnold, "Stainless Steel for Television", RCA Publication No. ST-563. Reprinted from *Metal Progress*, June 1950, pp. 761-764.

*Quartz-to-Metal Seal. Fig. 5. Patent No. 2,699,847.* Filed September 1, 1949. Issued January 18, 1955. One sheet of drawings. Assigned to General Electric Company by Evan H. Nelson and Ernest B. Power.

This invention relates to seal-bodies of the type comprising at least one conductor hermetically sealed through a quartz body and adapted for sealing into apertures in quartz envelopes.

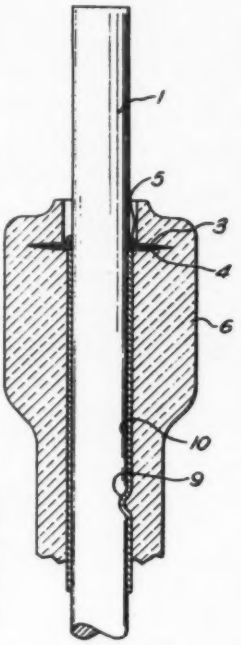



**Fig. 5**

Referring to Fig. 5, the seal-body comprises a metal rod 1, preferably tungsten, passing through apertures in two thin metal sheets in the form of annular discs 3 and 4, preferably of molybdenum. The discs 3 and 4 are hermetically united around the rod 1 by brazing or soldering as indicated at 5. The surface of each disc 3 or 4 in contact with the other disc is plane and the plane surfaces are in simple abutting contact with each other. The composite disc made up of the two discs 3 and 4 has a feathered seal edge which is embedded in the quartz body 6 to complete the hermetic sealing of the conductor rod 1 through the quartz body 6. The latter is preferably in the form of a tube having the end opposite that shown adapted to be hermetically joined to the quartz envelope of an electric discharge device, such as a high pressure mercury vapor discharge lamp. With this arrangement the opposing inner surfaces of the two sheets are free to move relative to each other and in this way stresses set up on cooling of the heated quartz in manufacture, or during use of the seal-body, which might lead to rupture of a single thin sheet, can be relieved by such relative movement without damage. The patent contains seven claims and the following references were cited: 1,271,245, Rechlinghousen, July 2, 1918; 1,293,441, Housekeeper, Feb. 4, 1919; 1,564,690, Kruh et al., Dec. 8, 1925; 1,722,016, Ronci, July 23, 1929; 2,198,769, Goodale, Apr. 30, 1940; 2,374,546, Laico, Apr. 24, 1945; 2,415,412, Buchwald et al., Feb. 11, 1947; and 2,518,944, Scott, Aug. 15, 1950.

# MORE areas in MORE tanks use MONOFRAX® refractories

**FOR FASTER SETTING,** plate glass tank uses large MONOFRAX H blocks in breastwalls, port jambs and arches, port neck sidewalls and crowns, regenerator mouth arch assemblies, crown skews, and complete gable wall including doghouse opening arch, relief arch and door shapes. MONOFRAX shapes are shown in blue.

Your choice of refractories for each area of your tank can determine the quality of your glass and the efficiency of your operation. Take this plate glass tank, for example.

The extreme purity of MONOFRAX H fused cast refractories, plus the almost complete absence of glassy phase, safeguard glass quality by helping to reduce seeds, stones and cords. That's because MONOFRAX blocks consist of over 98% alumina with less than 0.2% impurities and next-to-no interstitial glass.

Possibility of erosion is further reduced by using large blocks. These mean fewer joints, fewer places for erosion to start. And because these blocks are carefully made to close tolerances, no cutting is needed to make them fit. Faster setting is achieved to help cut installation costs.

Look into MONOFRAX refractories* to lengthen the life of more areas in your tank, above the glass line and below, and to improve glass quality. For more information just write—

*Have you tried the new Monofrax S Zircon-Alumina Fusion?*

**CARBORUNDUM**

Registered Trade Mark

Dept. L117, Refractories Division, Perth Amboy, N. J.

**Sensitizing . . .**

(*Continued from page* 684)

*Tin With Uranium:* The introduction of uranium oxide will substantially decrease the electrical resistance of the tin film formed, according to Mochel. A typical illustration of such a compound accordingly consists of:

| | |
|---|---|
| Tin chloride | 89-96 parts |
| Uranium oxide | 2.2 parts |
| Copper oxide | 0.2 parts |

In electron tubes it is often desirable to have a conducting film on certain defined inner sections of the glass envelope to prevent or dissipate electrons (static charges) accumulating on the glass. Campbell, of the Naval Research Laboratory, Washington, D. C. dissolves tin chloride in isopropyl alcohol and sprays it on the hot glass at its annealing temperature, all the time the tube is rotating. Films with resistances between 50 ohms and several megohms per square have been formed.

*Titanium Chloride*: This compound is referred to by Littleton, but he gives no details for its use. The tetrachloride has as its chemical formula $TiCl_4$; it is a heavy clear liquid, colorless and ranges from yellow to red in color, depending on its purity. It absorbs moisture from the air and evolves a dense irritating fume and is soluble in water with the evolution of heat. It is available from Stauffer Chemical Company.

Gaiser recommends the following solution for use in irridizing technique:

| | |
|---|---|
| Carbon tetrachloride | 1000 parts |
| Titanium tetrachloride | 10-15 parts |

Waddington refers to the manufacture of the compound, but does not mention its use as a sensitizer.

This compound, of course, is acidic and equipment resistant to attack must be used. Stainless steel, to stand up satisfactorily, and of course rubber lined equipment is suitable.

*Titanium Diacetate Hydrochloride*: The titanium content is expressed as $TiO_2$ and is about 31 per cent. The hydrochloric acid content is about 28 per cent and approximately 46 per cent acetic acid. The product is made by the Titanium Pigment Corporation. At 23 deg. C. the water solubility is about 20 per cent $TiO_2$ by weight. The compound is hygroscopic.

This salt, like all titanium salts, will hydrolyze and as a result, in preparing dilute solutions, it is advisable to add cold water to the salt, then gradually form the solution and dilute it carefully.

The usual precautions in storing hygroscopic salts such as aluminum chloride should be taken with titanium diacetate hydrochloride. Of course, it should not be allowed to stand in open containers. You will notice an odor of acetic acid which is characteristic of the compound but it does not mean that the acetate content is appreciably volatile. The yellow color of the sample is due primarily to the grain size of the material and is not indicative of lack of purity.

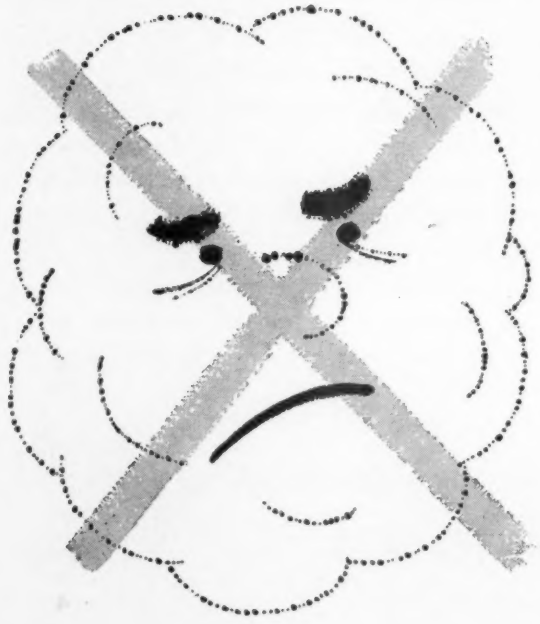
*Titanium Oxide*: Cox refers to the use of this compound in his patent, but gives no details for its use.

*Titanium Sulphate*: This is offered by the Titanium Pigment Corporation and the Carborundum Metals Company. The "titanyl" derivative is highly hygroscopic and unstable. It has been tested for use as a sensitizer and

(*Continued on page* 708)


# END DUST MENACE

## to your refractories and workmen with



# SOLVAY POTASSIUM CARBONATE

. . . dust-free . . . tops in quality

***Other Solvay glass chemicals:***
**Soda Ash · Sodium Nitrite**
**Ammonium Bicarbonate**

SOLVAY

*Write for samples and data*

**SOLVAY PROCESS DIVISION**

Allied Chemical

ALLIED CHEMICAL & DYE CORPORATION
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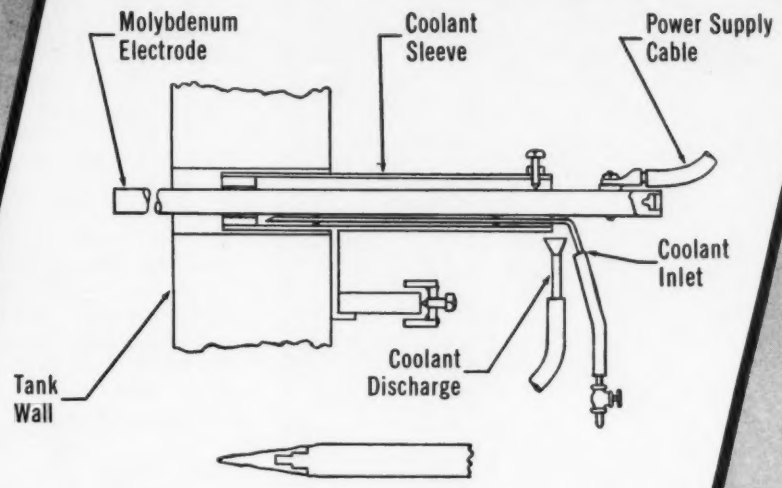
Hot molybdenum ingots are forged into round billets, then further processed to make 1¼-inch diameter electrodes for glass melting furnaces using the Penberthy electrode assembly shown in the diagram.




Electrodes are joined by threaded ends to provide maximum use

# Fansteel Molybdenum Electrodes

## for electric melting...

**here's what they cost:**

Based on actual operational costs covering a production of 16,027 tons of flint glass over a period of several months, electrode cost amounted to *only 2½ cents per ton!*

**here's what you get:**

1. Increased production (10 to 30%)
2. Longer furnace wall life
3. Improved glass quality

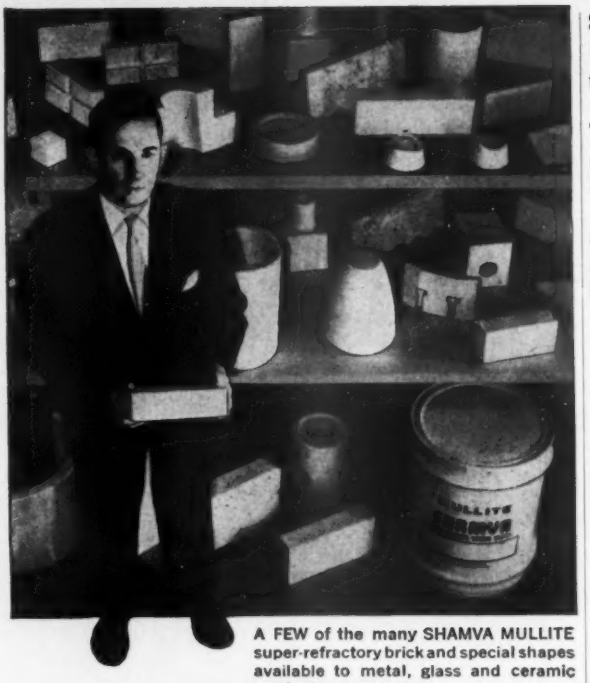
FANSTEEL ELECTRODES CAN BE INSTALLED WITHOUT FURNACE SHUT-DOWN . . . are 99.9% pure, give off a colorless oxide, have high thermal and electrical conductivity, and high temperature strength. Write for more complete information.

FANSTEEL Golden Anniversary of Progress

K577

**FANSTEEL METALLURGICAL CORPORATION**

NORTH CHICAGO, ILLINOIS, U. S. A.



A FEW of the many SHAMVA MULLITE super-refractory brick and special shapes available to metal, glass and ceramic producing companies.

For refractory economy...

**SHAMVA**

**MULLITE PRODUCTS**

Each of the SHAMVA products shown possesses a unique combination of properties that sets SHAMVA Mullite apart from other refractory products . . . and gives you the true economy of long refractory life:

- high melting point
- high softening point
- minimum expansion
- resistance to spalling
- load bearing strength
- resistance to slag
- low heat conductivity
- chemical neutrality

You'll like the uniform high quality of SHAMVA Mullite super-refractory brick and special shapes. And you'll like the practical, economical answers to refractory problems The Man from Mullite can provide.

The Man from Mullite—a trained field engineer—is ready to recommend or develop SHAMVA Mullite Products for your particular service. Why not call him soon? For free brochures, write:
*Mullite Works, Refractories Division,*
*H. K. Porter Company, Inc.,*
*Shelton, Conn.*

**H. K. PORTER COMPANY, INC.**
REFRACTORIES DIVISION
MULLITE WORKS


**Sensitizing . . .**

(*Continued from page* 706)

the results were fair.

*Triethanolamine Titanate*: The chemical formula is $Ti\ (OCH_2CH_2)NCH_2CH_2OH)_2$. This has been tested as a sensitizer and found to have interesting possibilities. It is offered by the Titanium Pigment Corporation.

Some of the titanium compounds are readily available at prices lower than tin chloride, and because of its availability during the war period there was concerted effort towards its possible use.

*Vanadium Tetrachloride:* This compound is referred to by Gaiser as a means for irridizing purposes.

*Zinc Compounds:* Are referred to by Santomiere for irridizing purposes, but no details are given for its use.

*Zinc Acetate:* Wheeler, McGinnis and Thordarson refer to this compound but gives no details for its use. A recommended solution given by Lytle and Junge is made up of:

| | |
|---|---|
| Zinc acetate | 20 grams |
| Phenyl hydrazine hydrochloride | 5 grams |
| Water | 50 grams |

*Zinc Nitrate:* This is referred to by Wheeler, McGinnis and Thordarson but they give no details for its use.

*Zinc Oxide:* Cox refers to the use of this compound in his patent, but gives no details for its use.

*Zinc Sulphate:* Conakov and Totesh refer to this compound but give no details for its use.

*Zirconium Acetate:* This compound is made by the Titanium-Zirconium Company and by the Titanium Alloy Division of the National Lead Company. It is available commercially as a light amber solution, stable from below freezing point of water to its boiling point –218° F. In powder form it contains about 50 per cent zirconium oxide and is slowly soluble in water. It is also offered by the Zirconium Corporation of America.

*Zirconium Chloride:* Is available as a yellowish as well as a white powder, readily soluble in water. Littleton refers to its use but gives no details. The tetrachloride is referred to by Gaiser but no details are given for its use. The oxychloride has at its chemical formula ZrOCl and is available from the Carborundum Metals Co. Very dilute solutions hydrolyze rapidly and precipitate hydrous zirconium oxide which is apparently the film

(*Continued on page* 710)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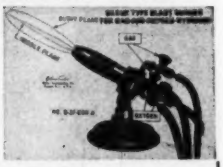

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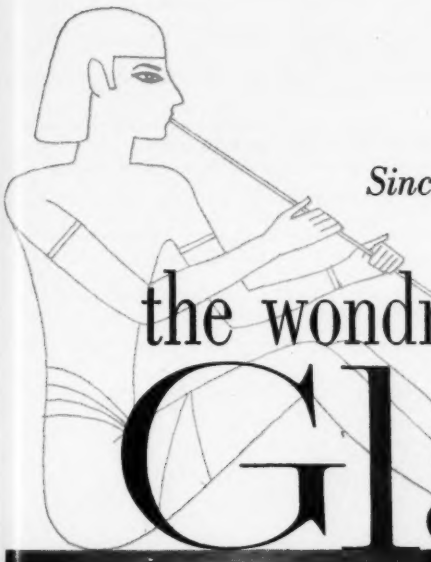

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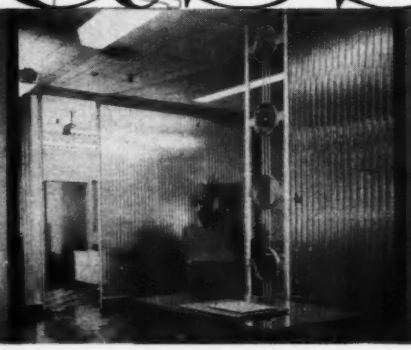

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**Sensitizing . . .**

(*Continued from page* 708)

observed when washng the glass surface with this. A solution used by the author and found to give satisfactory results consists of:

| | |
|---|---|
| Zirconium oxychloride | 20 grams |
| Hydrochloric acid (35%) | 10 grams |
| Water | 248 ounces |

Mixtures of zirconium oxychloride with tartaric acid, which should prevent hydrolysis, should be subjected to experiment.

*Zirconium Oxide:* This is an extremely finely divided cream white powder and has encouraging possibilities; it is made by Titanium-Zirconium Company as well as by the Berkshire Chemicals Company.

*Zirconium Sulphate:* Snow white crystals, which are completely soluble in water to give a clear solution. Has interesting possibilities. It is offered by the Titanium-Zirconium Company, as well as by the National Lead Company.

### ERRATA

In the October issue of THE GLASS INDUSTRY, the article, Modern Concepts of Fracture and Flow. Part I: Equilibria of Particulate Bodies, the following errata were printed:

On page 553, second column, next to bottom equation: The limits 1 and 2 appear in large instead of small type, while the expressions fdt, mv, dt, and t appear in small instead of large type.

On page 554, second column, third line from bottom: $a=$ should read $a^-$.

On page 556, first column, third last line of text as well as in the caption of Fig. 5, the term:

$T = {}_{(\tau,} \text{——} {}_{\tau)}$ should read: $T = (\tau, -\tau)$.

On page 556, second column, second equation, the terms:

$$\frac{(1 + 1/q^8)}{x^8} - \frac{(1 + (1/q^{14})}{x^{14}}$$ should be in square brackets as they are on page 557 in the fourth equation.

On page 557, first column, second but last equation: The Letters $V_2$ and $V^1$ should be $v_2$ and $v_1$ to match the $v_2$ in the last equation.

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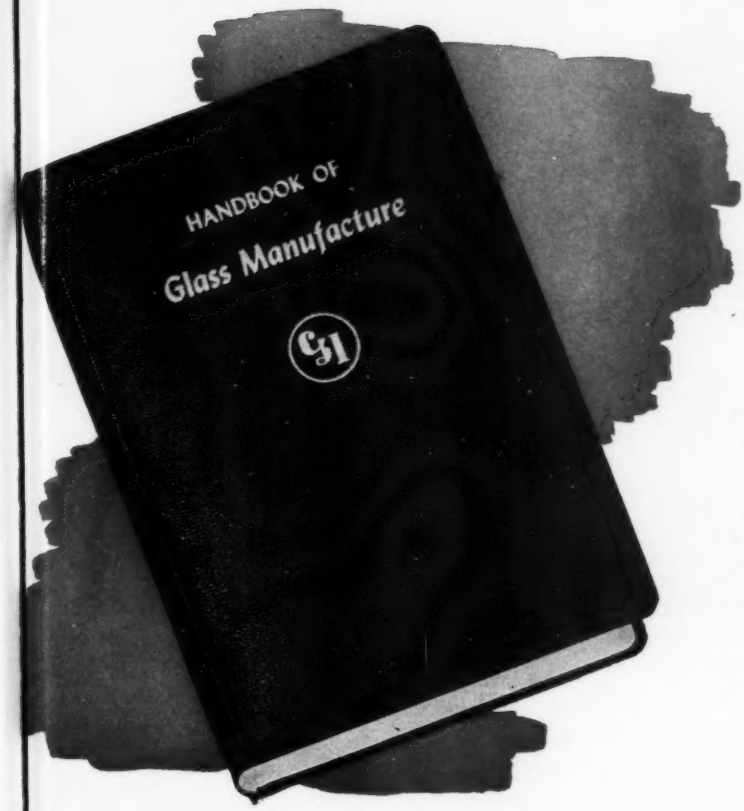


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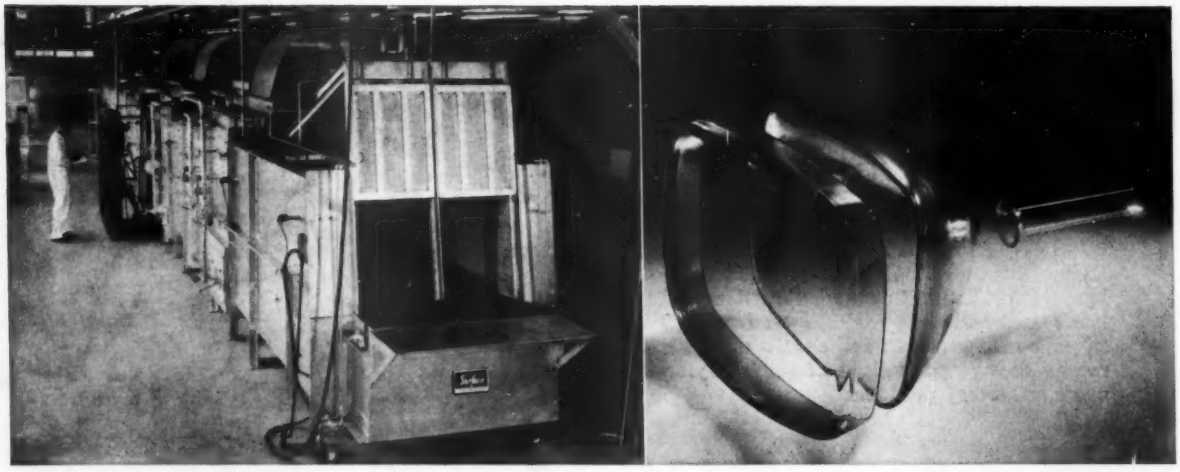
Even the most conservative estimates predict a tremendous growth over the next ten years in demands for glass and ceramic goods. This puts management in a difficult dilemma: their natural inclination is to keep pace with this accelerating growth, yet they want to protect their earnings from the heavy costs of adding plant space.

A happy way out of this dilemma is provided by modern heat processing equipment built by Surface Combustion Corporation. In many cases, this provides the required "inward" expansion because it increases capacity per man hour and per square foot of existing plant space. It protects earnings as well, because it combats competitive prices and materials through lower unit cost and improved product quality.

An investment in Surface Combustion equipment (lehrs, kilns, ovens) yields many returns—in economical expansion of capacity, in production savings, and in better products.

Surface Combustion Corporation, Glass Division, 2378 Dorr Street, Toledo 1, Ohio.

**SURFACE COMBUSTION**



*This Surface Combustion continuous experimental lehr produces the most exacting time-temperature conditions in the search for processing better television tubes.*

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